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**The Use of Information Design to Help Minimize
Medication Error Caused by Confusion of Drug Names**

Visual Communication Design
Master's Thesis Project

Fall 2005

Dedication

This document is dedicated to my father and mother, Domenico and Anna Gabriele, who have provided me with love and support throughout the years.

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Abstract

This exploratory study examined how information design could help minimize medication errors that take place in the administering phase of the medication process in acute care hospitals. The focus was on errors that occur due to confusion between look-alike/sound-alike drugs names (names that have orthographic and/or phonetic similarities). The severity of the problem was examined, along with theories about why these errors occur.

The objective was to develop design recommendations by testing the content and formal aspects (typography and composition/layout) for a labeling system intended to help minimize error. Labels were designed with the assumption that errors arise because of environmental or organizational processes surrounding the incident and take into consideration the affective, physical and cognitive strengths and limitations of nurses who administer medications. In order to determine how to make drug names distinctive and labeling easy to read and understand, an interdisciplinary approach was used. This included research into drug information and naming, human factors psychology, cognitive psychology, psycholinguistics, perception, content issues, typography and layout/composition.

To determine the effectiveness of labeling, quantitative and qualitative methods were used in testing prototypes with end-users (acute care nurses). Results from word recognition tasks and label identification tasks were useful in the evaluation of the design variations and the inclusion of information not normally present on labeling. Questionnaires helped to compare attitudes and opinions of the same material.

The results of testing suggest that information design, applied to medication labeling, might help minimize errors due to look-alike/sound-alike drugs by considering the following:

- 1) The inclusion of additional content, such as therapeutic class could be helpful in the identification of drug labels for look-alike/sound-alike drugs,
- 2) Visual differentiation within drug names may assist in distinguishing look-alike/sound-alike drug names, and
- 3) Items grouped together in meaningful chunks could help to make information easier to find.

Though limited in sample size, testing provided positive feedback on the design of labeling and an indication that the testing methods utilized in this exploratory study could be used successfully in a larger study.

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Introduction

The Context

Healthcare is a priority for most governments in the western world because of aging baby boomers who will live longer than any group before them. As access to healthcare becomes more important, attention is focused on every aspect of medicine, including patient safety and the quality of care offered.

In the past few years, advances have been made in the UK, Australia and the USA in identifying, documenting and implementing measures to avoid the occurrence of preventable errors. In 2000, *To Err Is Human: Building a Safe Health System*, Kohn, Corrigan and Donaldson, eds. was published by The Institute of Medicine to address the state of errors in the American medical system in order to help improve the quality of healthcare in the USA. This report has provided an incentive to reduce the incidence of error and to promote safe care for patients in the United States. It has served as a benchmark for other countries.

A Canadian report that reveals the degree of safety in the healthcare system was published in 2002 by Health Canada. *Patient Safety and Healthcare Error in the Canadian Healthcare System: A Systematic Review and Analysis of Leading Practices in Canada with Reference to Key Initiatives Elsewhere* (G. Ross Baker and Peter Norton) examines incidences of error and patient safety. It identifies the problems that exist in healthcare facilities and outlines opportunities for improvement. By conducting a literature review, telephone and mail surveys and analyzing gaps that exist in current practices, the researchers revealed that medication errors¹ were at the top of the list of patient safety or healthcare issues. (82)

¹*The Canadian Patient Safety Institute defines medication errors as “the failure to complete a planned action as it was intended, or when an incorrect plan was used, at any point in the process of providing medications to patients.” (CPSI, 31)*

Around the world, the open reporting of adverse² events is seen as a step towards creating a culture of safety. (CIHI, 17) Healthcare workers are trained to function at a high level of competency and it is implied that if they are properly trained, they will not make mistakes. (Leape, 1994, 1851) In the past few years, there has been a movement away from this view of “perfection” and of looking at errors as being the fault of individuals. Instead, an error is viewed as a symptom of problems, within a larger system that has failed. (Leape, et al., 35). By identifying the incidences of errors and examining the root causes, it is possible to isolate elements within the system that are contributing to errors and an opportunity to design solutions intended to reduce or eliminate them.

²*“[Adverse events] are unintended injuries or complications resulting in death, disability or prolonged hospital stay that arise from health care management.” (Baker, G.R. et al., 1678)*

Medication Errors

In the first Canadian study that provides a national estimate of the occurrence of adverse events, it was reported that 7.5% of patients admitted to acute care hospitals in Canada, in 2000, experienced one or more adverse events and 24% of these were drug or fluid related events. (Baker, et al., 1678) This study provides an impetus to improve patient safety by monitoring errors and modifying the conditions under which such incidences occur in order to reduce the number of adverse events. (1685)

Professor James Reason, the leading authority on the topic of human error, believes that error in medicine can be viewed in two ways, either from a “person” approach or a “system” approach. The person approach involves the “unsafe acts of people at the sharp end,” for example, errors caused by the front-line healthcare workers who are closest to the patient. With the person approach, errors occur because of forgetfulness, inattention, poor motivation, carelessness, negligence and recklessness and promote a culture of blame, based on moral weakness. With the system approach, errors occur

Introduction (cont.)

somewhere “upstream” or early on in the sequence of events leading up to the incident. In this model, it is assumed that humans are not perfect and will make errors but, those errors occur because of circumstances surrounding the error that are out of the control of the individual, such as environmental or organizational processes. (2000, 768)

In May of 2001, the American Federal Drug Administration (FDA) collected reports of 265 cases of medication errors. Of those, 129 were considered serious. These errors were reviewed and classified according to the Taxonomy of Medication Errors, (developed by The National Coordinating Council for Medication Errors Reporting and Prevention (NCC-MCERP) and adopted by the FDA). Human factors and communication accounted for 61% of errors, while labeling, packaging/design and name confusions (circumstances, not under the control of the healthcare worker), accounted for 39% of errors. (Thomas et al., 23) The high rate attributed to systemic causes are significant enough that the medical profession needs to address deficiencies in organizational processes and decisions that impact patient safety.

Figure 1
Medication Errors
by Cause

Causes of Medication Errors	Number (n = 341)	% of Total
Human factors (n = 145, 42%)		
Knowledge deficit	42	12.3
Performance deficit	45	13.2
Miscalculation of dosage or infusion rate	24	7
Drug preparation error	8	2.3
Transcription error	24	7
Fatigue	1	0.3
Computer error	1	0.3
Labeling (n = 68, 20%)		
Immediate container labels of product manufacturer, distributor, or repackager	32	9.4
Labels of dispensed product – practitioner	15	4.4
Carton labeling of product	15	4.4
Package insert	1	0.3
Electronic reference material	2	0.6
Printed reference material	3	1
Communication (n = 64, 19%)		
Verbal miscommunication	1	0.3
Written miscommunication	28	8.1
Misinterpretation of the order	35	10.3
Name confusion (n = 44, 13%)		
[Brand] name confusion	35	10.3
[Generic] name confusion	9	2.6
Packaging/design (n = 20, 6%)		
Inappropriate packaging or design	10	3
Dosage form (tablet/ capsule) confusion	9	2.6
Devices (infusion)	1	0.3

(Adapted from Thomas et al., 23)

Introduction (cont.)

The Target Audience

In acute care units, medication errors can occur at any stage of the medication process (prescribing, dispensing and administering, monitoring, and controlling systems and management). The target audience for this study are the nurses charged with the day-to-day care of patients. These nurses were selected as the target group because they are the individuals most likely to administer medications to patients and, therefore, the last person in the process who would detect an error.

Figure 2
The Medication Process

1) Prescribing	
Assessing the need for and selecting the correct drug	• Physicians
Individualizing the therapeutic regimen	• Licensed Practical Nurses
Designating the desired therapeutic response	
Documenting or transcribing	
2) Dispensing	
Reviewing the order	• Pharmacists
Processing the order	
Compounding and preparing the drug	
Labeling/packageing or relabeling/repackageing the drug	
Dispensing the drug in a timely manner	
3) Administering	
Preparing the drug/device	• Registered Nurses
Administering the right medication to the right patient	• Licensed Practical Practitioners
Administering the medication when indicated	• Physicians
Informing the patient about the medication	
Including the patient in administration	
4) Monitoring	
Monitoring and documenting patient's response	• Physicians
Identifying and reporting adverse drug events	• Licensed Practical Practitioners
Reevaluating drug selection, regimen, frequency, and duration	• Pharmacists
	• Nurses
	• Administrators
5) Systems and Management Control	
Collaborating and communicating amongst caregivers	• Physicians
Reviewing and managing patient's complete regimen	• Licensed Practical Practitioners
	• Pharmacists therapeutic drug
	• Nurses
	• Administrators

(Adapted from Berman, 10, Kohn et al., 38, Nazdam, 1925)

In administering drugs to a patient, a nurse is trained to go through a series of “checks” to ensure that they are administering the proper drug to the proper patient. These are known as the “five rights”: identifying the right drug, the right patient, the right dosage, the right time, and the right route of administration. This involves crosschecking the medication with charts, prescriptions, identification

Introduction (cont.)

bracelets and labels. This type of verification is considered a standard for safe medication practices, but the Institute for Safe Medication Practices (ISMP) claims that this checklist can only work if there are procedures and systems in place to ensure that these checks can take place with accuracy. The “five rights” focus on the individual performance of nurses – the last part of a process that involves the work of many other individuals, some of whom are physicians, pharmacists, administrators, pharmaceutical companies, architects, designers of medical devices and packaging, and the processes and products that they generate. (ISMP, 1999)

Acute care nurses work under difficult circumstances that are taxing intellectually, physically and emotionally. They are dedicated, nurturing and committed individuals responsible for the care of patients who are often very ill. Exposure to infectious bacteria and viruses is an everyday occurrence. Typically, they work a variety of shifts; nights, weekends and holidays (Alberta Human Resources and Employment, ¶6,7) and often, multiple shifts and long hours. All of these factors contribute to stress and can affect their behavior in the workplace in a negative way and lead to adverse events.

Fitness to Practice: the challenge to maintain physical, mental and emotional health, published by the Registered Nurses Association of British Columbia (RNABC) outlines the difficult challenges of caring for patients. It identifies conditions in the work environment and the detrimental effects to nurses and their employers. They believe that if nurses experience problems in their physical, mental and emotional well being, their cognitive functioning, decision-making, reaction time, judgment and ability to be flexible and handle stress are negatively affected. This puts their health at risk and, consequently, poses a threat to patient safety. (2)

Problem Definition

Origin of the Problem:

Look-alike/sound-alike Drug Names

One of the reasons that patients might receive an incorrect medication is the confusion that arises when a drug name is dangerously close to another orthographically (in written form) or phonetically (in spoken form). This is known as a look-alike/sound-alike drug name. However, in determining why an error has occurred, one must look beyond the orthographic and phonetic similarities in the names and examine the circumstances that have contributed to errors. Health Canada states:

“These similarities may pose a risk to health by causing errors in prescribing, dispensing or administration of a product. These medication errors may be more likely to occur because of contributing factors such as identical doses, dosage forms or routes of administration, similar packaging or labeling, incomplete knowledge of drug names, illegible or unclear handwriting, verbal order errors (similar phonetics), orders that are look-alike/sound-alike or incomplete, data processing errors, errors in documentation and even lack of appropriate knowledge base.” (BGTD, HPFB 5)

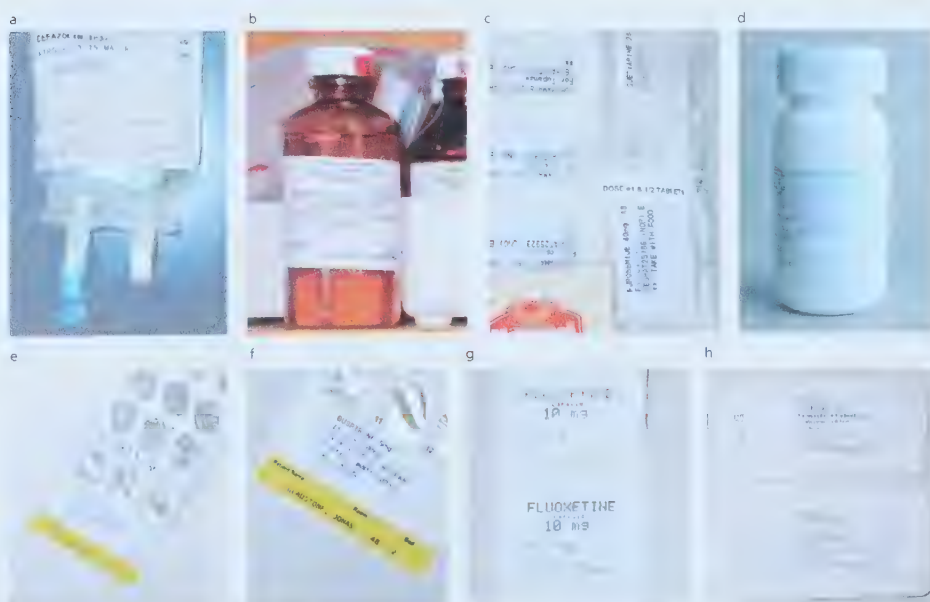
In a hospital pharmacy, it is common for medications to be relabeled or repackaged and sent to acute care nursing units for administration to patients. It is possible for the institution to customize these labels for specific needs in terms of typography, layout and content as these labels are generated by the pharmacy and not by the drug manufacturer. The labels contain drug- and patient-specific information such as the patient name, medication name, dose, instructions for use, etc. Typically, labels are printed on ink jet or laser printers and are attached to various types of packages and containers, some of which include:

- commercial packaging, with some preprinted information;
- bulk packaged drugs that have that are repackaged in bottles, vials, blister packs and plastic bags;
- unit dose packaging – individual doses of pills or capsules that come pre-packaged in unit doses from pharmaceutical manufacturers or packaged from bulk in the hospital pharmacy; and
- medications that are a combination of more than one drug and mixed in hospital pharmacy and are repackaged in intravenous bags, syringes.

Figure 3, a-h

Examples of medication labeling from an acute care hospital pharmacy:

- I.V. bag label
- bottle labels
- plastic bag label
- relabeling of retail bottle
- 12 day dose card
- detail, 12 day dose card
- hospital pharmacy unit dose packaging
- commercial unit dose packaging



Problem Definition (cont.)

Delimiting the Study

- 1) This study is concerned with orthographic similarities of look-alike/sound-alike drug names and does not directly addresses phonetic issues.
- 2) The differentiation made between names is, in this case, visual rather than semantic.
- 3) The use of colour as a differentiation tool has not been considered in this study for two reasons. First, most labeling that is generated in hospital pharmacies is limited by the technology and only allows for black ink. Secondly, the Institute for Safe Medication Practices has found that colour coding of medications can contribute to errors, rather than help to prevent them. (ISMP, 2003a)
- 4) The labels that have been designed for this study are intended for use in an acute care hospital setting and would be attached to many types of packages. One of the hospitals involved in the testing used a 12 day blister card system, requiring the labels to be designed in order that they could be affixed to preprinted cards. In the case of a hospital where plastic vials or plastic bags are in use, labels would be attached to those.

“Our hospital uses a 12 card controlled dosage system for our medication distribution system in acute care... [M]edications are blister packaged into 12 day cards for acute care and labeled with medication identification - generic name, trade name or equivalent, dosage, control #, manufacturer, and expiry date. When an order is received for a patient, a patient name label is affixed to a blister packaged card which includes first and last name of patient and the patients location (room #)...One card is sent to the ward for every time the medication is to be given (i.e. TID [three times a day] order - three cards)...” (Waknuk)
- 5) Because this is an exploratory study that tested design proposals with a limited number of participants, it cannot provide definitive results. Instead, it can only suggest directions for future research.

Figure 4
12 day card dosage system



The Framework

The Importance of Human Factors Psychology

The field of human factors psychology examines how humans interact with their ‘systems’ (the environment in which they work, the equipment and tools they use and their procedures and protocols) in terms of basic human capabilities: attention span, memory span, perceptual abilities and physical limitations. Human factors psychologists have developed procedures that help in the design and evaluation of systems. (Proctor, Van Zandt, 5)

For a number of years, human factors practices have proven to be successful in looking into complex systems to determine root causes in aviation accidents and other large scales systems failures such as nuclear disasters and blackouts. Medical professionals, concerned with incidences of error, are taking measures to help reduce the occurrence of adverse events by making use of the practices of human factors psychology that have been successful in other domains. (Kohn, et al., 63)

Organizations such as the Institute for Safe Medication Practices endorse the use of human factors engineering principles to improve health care systems. Specifically, failure mode and effects analysis (used to identify and prevent potential problems) and root cause analysis (used to identify underlying causes of errors that have occurred to help prevent future occurrences) have been used in order to improve system processes and replace the culture of blame with the culture of safety. (Greenhall, et al., 111, 112)

Designing for People: Human Factors Testing and User-centred Design

Because of its foundations in human performance psychology and industrial engineering, human factors psychology makes use of sound methods for obtaining research and data to back up theories. Its beginnings trace back to the industrial revolution, when a new labour force emerged along with issues of worker safety and health in relation to productivity. (Dempsey, Wogalter, Hancock, 4)

Human factors psychology and design are inextricably linked. Both are concerned with how the end-user interacts and behaves in relation to a designed artifact, whether it is a product, an environment or visual communication. Both must develop a “prediction,” in order to affect changes in a situation or affect user behavior. The designer must be well acquainted with the problem and understand the users information processing in relation to the product or system in its context and the environment (Popovic, 27). The importance of research, testing and evaluation methods become critical in the creation and validation of solutions, in order that they will be effective. In his book, *User-centred Graphic Design*, Professor Jorge Frascara relates design to scientific processes by proposing that the research and paradigms that shape the design solution, work as a hypothesis throughout the process, and that the final recommendations require scientific testing and analyses in order to prove their effectiveness. (5)

Psychologist and author, Donald Norman acknowledges that human beings routinely make errors and that designers should design with this in mind. Rather than simply looking at the relationship between human error and behavior, Norman believes designing with a user-centred philosophy allows for examination of the interaction of humans and their “machines” and that problems can arise on both sides, contributing to error. (140)

The Framework (cont.)

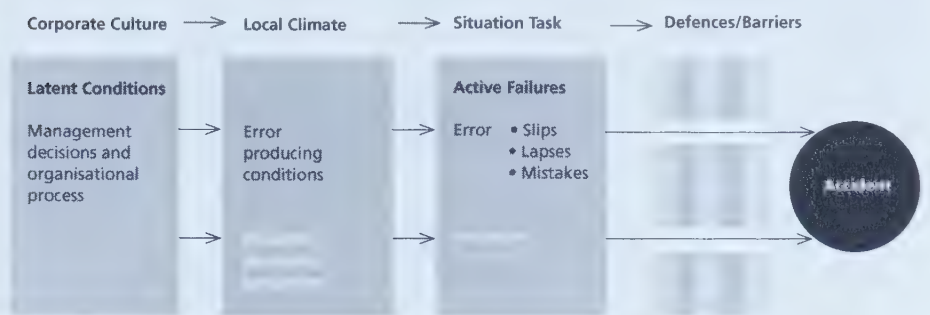
Categorizing Human Error

James Reason's theory of human error and model of accident causation provide a framework for breaking down and identifying the factors that contribute to errors. As stated previously, Reason believes errors can be examined in two ways, the "person" approach and the "system" approach. He sees errors that occur with the person approach as "active," with effects that occur right away. Errors that occur in the system approach are "latent," generally present long before the incident takes place. Both active and latent errors can be revealed in an organization that practices the open reporting of incidences as a key to identifying problems in a system. This allows the examination of errors in terms of the surrounding events and the pinpointing of the potential causes, which may not be immediately apparent. (2000a, 768)

Figure 4

*Reason's Model of
Accident Causation*

*Accidents can occur when
latent conditions bring
about error producing
conditions. Combined
with active failures
they can break through
defences and barriers
that are designed to
prevent accidents.*



Examples

Slip (attentional failure)	New drugs added to formulary	Nurses not familiar with new drug and/or potential for look-alike/sound alike problem	Break in attention while preparing tray and fails to recognize wrong drug name	Double checking (5 rights of medication administration or checking with physician)
Lapse (memory failure)	Poorly designed nursing units	Not enough counter space to prepare patient trays	Interruption during preparation and forget to double-check	
Mistake (inadequate or poorly implemented plan)	Inadequate Staffing	More than the usual number of patients	Lack of a good plan to deal with the large number of patients, lead to short-cuts with little time to double-check	

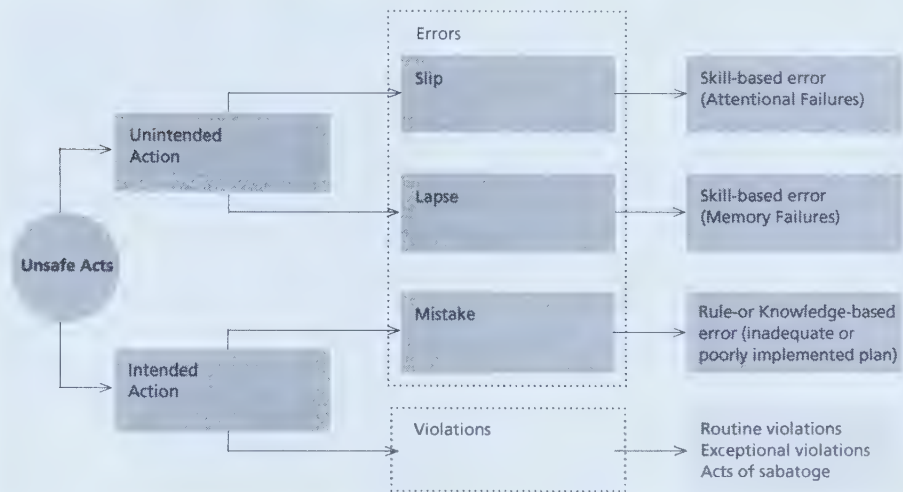
(Adapted from Reason, 2000b, 38)

The Framework (cont.)

The Distinction Between Errors and Violations

Reason makes a distinction between errors and violations. Slips and lapses (a result of unintended actions) and mistakes (a result of intended actions) come about because of informational problems. Violations are the product of deliberate actions that are associated with motivational problems. Errors can be explained by what goes on in the mind and can be reduced by eliminating the error producing conditions, while violations occur in within a social context and require motivational and organizational solutions. (2000b, 36) This exploration is concerned with designing for errors and does not extend to violations, which requires solutions beyond the scope of this study.

Figure 5
*Psychological Varieties
of Unsafe Acts*



(Adapted from Reason, 1990, 207)

Active Errors

Active errors are explained in terms of a person's cognitive processing and are divided into two categories: unconscious errors (slips and lapses) and conscious errors (mistakes). (1990, 9) Reason uses Rasmussen and Jensen's framework of human performance as skills, rules or knowledge-based activities to categorize specific types of errors that occur (as cited in Reason, 1990, 43).

SLIPS AND LAPSES

Slips and lapses are associated with skills-based activities, which are automatic and governed by stored patterns of preprogrammed instructions. Slips occur because of a break in attention (slips of action), while lapses happen because of memory failures (lapse of memory). (1990, 43, 107) Slips transpire at the execution stage and involve the processes in implementing a stored plan; lapses occur at the storage stage – the phase between formulating actions and implementing them. (1990, 12, 13) Slips and lapses take place when attention is diverted, either from a distraction in the immediate surroundings or a preoccupation with something in the mind or because of some type of change in the current plan of action. (2000b, 35)

The Framework (cont.)

MISTAKES

Mistakes are classified as rule-based or knowledge based activities. Rule-based activities are deliberate actions that help in problem solving by employing stored rules that come from training, experience or set procedures. When errors occur, it is because of a misinterpretation of the situation and the misapplication of a good rule or a lack of knowledge resulting the application of a bad rule. Knowledge-based activities are planned actions that use stored knowledge in novel situations. Errors occur when a solution has to be worked out, on the spot, without the help of preprogrammed solutions and a false generalization is applied to a situation. (1990, 43, 90, 2000b, 35) Mistakes happen at the planning stage of cognitive processing when identifying a goal and deciding on a means or a proper plan to achieve it. (1990, 12, 13)

Latent Errors

Latent errors occur when the circumstances surrounding or leading up to the error are faulty. Although they can lie dormant in a system for a long time, when combined with active failures, they can result in an error. (Reason 2000, 769) On examining the latent conditions associated with an incident, one uncovers the factors that have occurred that help in determining the root causes of the error. (Bryony, 1373) In acute care hospitals, prescribing errors have occurred because of organizational issues such as: inefficient protocols or procedures, understaffing, heavy workload, poor written or verbal communication and inadequacies in the physical environment: equipment, storage, packaging, labeling, insufficient access to patient and drug information. (Bryony, 1375) Latent errors occur because of decisions made by top-level management, designers, builders and procedure writers. (Reason, 2004, 769)

In determining when and where in a system these incidences take place, there is an opportunity to deal with deficiencies, to minimize them, so that those at risk of making an error are working under the best possible conditions. An important aspect of Reason's theory is that he believes people will make errors, but there are ways that they can be minimized by paying attention to human limitations and designing around them. He aptly sums up the system approach to dealing with error, "We cannot change the human condition but we can change the conditions under which humans work." (2000, 769)

Cognitive Processing

In testing the effectiveness of medicine labels, designed to help distinguish confusable drug names, it is important to understand theories of attention, memory, and information processing and how these theories affect recognition and recall of information.

Attention

Attention is the selective means by which we become aware of events in our environment. (Pettersson, 115) Attention is subjective, and we attend to information that is of interest by way of unconscious, automatic processes or conscious, controlled processes. It judiciously focuses limited mental resources on information and cognitive resources by blocking out stimuli that do not interest us. This allows us to store information in memory to which we have paid attention rather than focus on information which we have ignored. (Sternberg, 67)

The Framework
(cont.)

Psychologists use the term “automatic processing” to refer to skills that have become routine because they are very well practiced and require minimal effort. While this is often advantageous by allowing performance of multiple tasks simultaneously, it also makes it more likely for errors to occur. (Reed, 66) “Controlled processing,” on the other hand, is associated with unfamiliar or unpracticed tasks that require conscious attention. (Sternberg, 72) These tasks consume a lot of attentional capacity and therefore, can be easily disrupted. (Haberlandt, 84, 85)

Figure 5
Controlled versus
Automatic Processes

Controlled Processes	Automatic Processes
(conscious)	(unconscious)
Require intentional effort	Require little or no intention or effort
Require full conscious awareness	Generally occur outside of conscious awareness
Consume many attentional resources	Consume few attentional resources
Performed one step at a time	Performed simultaneously, in no particular order
Time consuming	Fast
Novel and unpracticed tasks	Familiar and highly practiced tasks
Requires high levels of cognitive processing	Requires low levels of cognitive processing
Difficult tasks	Easy tasks

(Adapted from Sternberg, 72)

Slips and lapses occur while performing skills-based tasks and are a result of automatic, unconscious processes. Mistakes can happen while performing rule-based tasks that are a function of automatic, unconscious processes while those that are knowledge-based involve controlled, conscious processes.

SELECTIVE ATTENTION:
FILTER AND BOTTLENECK THEORIES

Filter and Bottleneck theories focus on the way in which sensory data comes to our attention and is filtered for processing. Broadbent’s Filter Theory illustrates how we take in sensory information through a number of parallel channels that is filtered before perception, so that information passes through a limited capacity channel and is recognized, while other information is blocked out. (242, 297-299) The filter is selective and switching channels to attend to other information takes time. (211) Selection takes place early in the process, based on features of the information, rather than meaning, which is assigned subsequent to filtering.

Similar theories have been proposed, that vary in terms of how much of information is recognized and/or where in the process filtering takes place, i.e., where the ‘bottleneck’ occurs. Triesman’s Model of Attenuation shows that two channels of information are recognized and that the one with less intensity is weakened, rather than blocked. (453) In this model, information from both messages are analyzed for their features. Weakened signals with a certain level of intensity are processed further for structure before filtering. Their importance determines passage to the next level of analysis for meaning. (453, 459)

The Framework (cont.)

In the Deutsch and Deutsch model, information is selected even further on in the process. This model illustrates that individuals will recognize any incoming information, whether attention is paid to it or not and it is analyzed, according to its relative importance to other information that is perceived and is then selected based on meaning. (83, 84)

These models are important because they show that not all sensory information is perceived or attended to, suggesting that visual information presented to a viewer must be distinctive enough in order to compete with other messages.

RESOURCE THEORIES:

ATTENTION, EFFORT AND CAPACITY

Resource theories assume that attention is a reservoir of information-processing resources available to mental functions. (Reason, 1990, 29) Kahneman's capacity theory of attention assumes that each task a person performs is allotted a set standard amount of attention/effort/capacity (these three are synonymous in this context). (26) Capacity is based on the level of arousal, with more available when arousal is high. Attention is a conscious activity and is extended, based on the requirements of task; some tasks require more attention, while others require less. (131, 132) Attention is controlled by feedback generated by the ongoing activities. When there is a rise in the demand of the activity, it causes an increase in the level of arousal, effort and attention. Errors can occur if less attention is placed on a task (which can be a result of allocating effort to another activity) or if there is not enough capacity to meet the demands of that task. (26, 27, 17)

DESIGN FOR LIMITATIONS IN ATTENTION

Professor of information design, Rune Pettersen explains that in any situation, there is always far more sensory information than we can ever detect and transmit to short-term memory. We select information we want to see or to hear and ignore the rest. (116)

In Pettersen's opinion, it is the role of the information designer to first, gain the attention of the audience and then to maintain it. (125) Attention span, the length of time that one can focus on an object or topic, does not usually last for very long. (Therefore, in order to maintain interest, information must be presented so that it is not predictable or boring.) The information designer can influence how the reader will respond if they understand that the viewer's attention will be attracted by things that:

- are novel
- have a distinct direction
- have good contrast
- are unusual shapes
- are large, bold and clear
- deviate from the surroundings
or from familiar patterns
- are relevant (115-122)

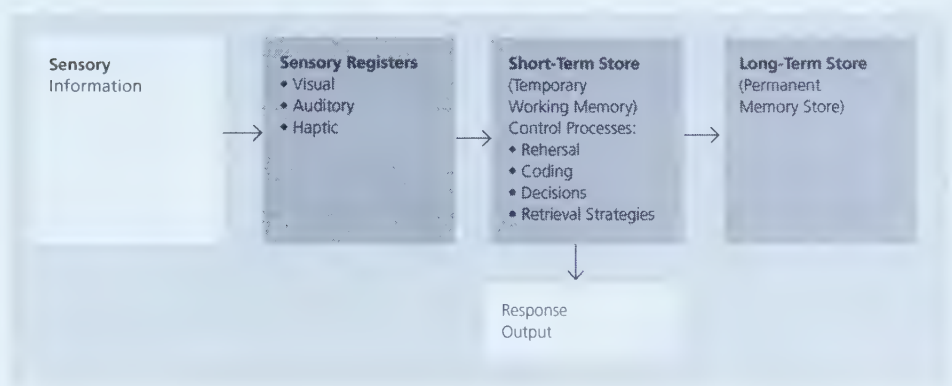
The Framework (cont.)

Memory

THE TRADITIONAL VIEW OF MEMORY

Memory is the instrument by which we make use of our knowledge and skills in day-to-day functioning. (Tulving, 2000, 161-162) In the traditional model of memory there are three distinct types of memory: sensory memory, short-term memory (STM) and long-term memory (LTM). Atkinson and Shiffrin's metaphorical model, depicts memory as three structures: a sensory register, short-term store and long-term store and the information contained in each of the stores. (82, 83)

Figure 6
Traditional Model
of Memory



(Atkinson, Shiffrin, 82)

The Sensory Register

The sensory register acts as a temporary buffer for information that comes to us through the senses: a visual sensory register that obtains information from visual stimuli; an auditory sensory register that obtains information from aural stimuli; and haptic sensory register that obtains information from tactile stimuli. (Atkinson, Shiffrin, 82,83)

Short-term Memory (STM)

From the sensory register, information then passes into STM, also known as working memory, because it is used in conscious activity. (Atkinson, Shiffrin, 82-90) In terms of retaining information in STM, Miller observed that its capacity is limited to seven items, plus or minus two and he also saw that more information was stored if it was grouped into meaningful "chunks." (81-97) STM is temporary and can decay rapidly if it is not encoded or attended to, or rehearsed for storage into LTM. (89)

Long-term Memory (LTM)

LTM contains information that has been learned, rehearsed and stored for retrieval into STM, for active use. It is assumed that information in the long-term store is relatively stable and permanent. (Atkinson, Schiffrrin, 83) LTM is generative rather than reproductive and "can be prone to error, illusion or distortion." (as cited in Lefrançois, 268, Schacter, et al.) It is influenced by the understanding of a central idea and meaningful things are more easily remembered. (Lefrançois, 268-270)

The Framework (cont.)

In *Understanding Reading*, Smith states that there are two bottlenecks to memory: STM's limited capacity and the slow entry of information into LTM. His solution to this problem is to organize it into its most meaningful, compact units because we have the tendency to chunk information automatically, depending on what we are looking for. In the case of words, we don't read h-o-r-s-e, but rather, "horse" and in looking at a person's face we see the entire face, and not the eyes, ears, nose and mouth separately. If the material we are reading is set up to support meaningful units, we are more likely to recall and retain this information and overcome memory limitations. (272)

Success with chunking information to facilitate reading is illustrated in a study by Frase and Schwartz, who had adults read complex information in several technical passages and rated them on how quickly they could locate particular pieces of information. Meaningfully-segmented text resulted in significantly faster and more accurate response times than standard text. In the case of non-meaningful segmentation in comparison to standard text, the time was significantly slower. (Frase, Schwartz, 204)

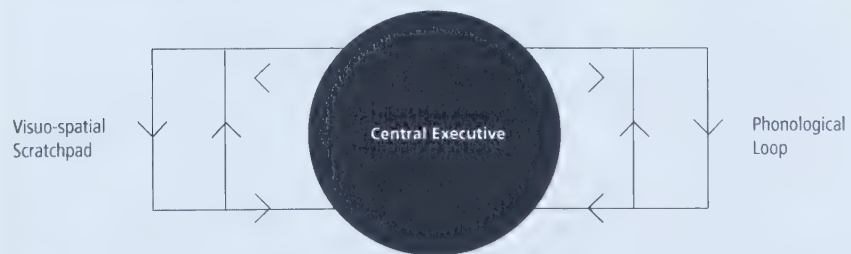
A drawback of the traditional model is that it explains memory as series of discrete, passive stores that hold information temporarily until it is needed and does not explain how new information is integrated with previously stored information. An alternative view is a model of working memory that is continuously and actively manipulating, reformatting and coordinating sound and images. Once stored, information is still available for reformatting and reintegration into working memory. (Sternberg, 163)

A MODEL OF WORKING MEMORY: HOW CONFUSION CAN OCCUR

Baddley's model explains working memory as being comprised of two distinct activities that are controlled by a "central executive," an attentional system that supervises and coordinates slave systems. These are the "articulatory" or "phonological loop" that processes speech based (acoustic, phonemic or phonological) information and the "visuo-spatial scratchpad" or "sketchpad," that processes visual and spatial information. (71) Both of these have two subsystems, a passive store and an active rehearsal process. (72) The central executive is responsible for managing the flow of information and processing for storage and retrieval from LTM, while the slave systems keep the sensory information active and accessible to the central executive. (Lefrançois, 266)

Figure 7
A Model of
Working Memory

Speech-based information and visual/spatial information are processed separately but kept active while performing tasks. Both are controlled by the central executive.



(Adapted from Baddley, 71)

The Framework (cont.)

Memory traces in the phonological loop, left unattended, begin to fade and disappear between one and a half to two seconds. When memory traces are rehearsed, they are refreshed and converted into a phonological code. The phonological similarity effect (the impaired recall of similar items) occurs because recall of information requires discriminating between the memory traces. Items that sound similar have similar phonological codes and are more difficult to distinguish from one another, resulting in a lower level of recall. (Baddley, 72)

The visuo-spatial scratchpad/sketch pad works much like the phonological loop, in that it is fed directly through visual perception or indirectly by the generation of a visual image. It is the component of working memory that sets up and manipulates visual images and has both visual and spatial dimensions. (97, 105, 109)

This model explains that different types of information (speech-based information and visual/spatial information) are processed separately, how information is kept active, whether it comes from sensory data or information from LTM, and, of importance to this study, how confusion of similar items can occur.

LEVELS OF PROCESSING FRAMEWORK: HOW INFORMATION IS MADE MEMORABLE

Craik and Lockhart proposed “levels of processing,” a conceptual framework that explains why some information is lost from memory because the level of encoding is not sufficient. They proposed that information at the shallowest level is based on physical features, the next level is based on sound and the deepest level is based on meaning. The depth to which the information is being processed and the amount of retention is determined by:

- whether or not the stimuli are meaningful;
- the amount of attention devoted to the stimuli;
- the system of analyzing (with a word, it could be encoded in terms of one or more features—visual, phonemic or semantic, its verbal associates or an image); and
- the processing time available. (675, 676)

Based upon the elaboration, organization and distinctiveness of the encoding, perceptual information is made memorable. Elaboration refers to the richness of encoding and the associations made around the representation that are based on past experiences. (Craik, Brown, 164,165) Organization is the linking of representations based on meaning. Distinctiveness is the way in which a representation is made noticeable in relation to its surroundings. Good encoding supports better recollection of specific experiences or knowledge. (Craik, Brown, 164,165)

This framework is useful in that it describes specific ways information can be made more memorable for retention in LTM. The studies on which this framework is based use language in order to show how levels of encoding are represented by orthographic, phonological and semantic features of words, all of which are related to the issue of name confusion.

The Framework (cont.)

SCHEMA THEORY: HOW WE USE STORED KNOWLEDGE

Schemata represent our knowledge of a procedure, object, percept, event, sequence of events or a social situation. (Thorndyke, 167) In 1932, Bartlett defined schemata as the active organization of our past experiences that are continuously interacting with new information that contributes to or changes the schema. He saw this as the most fundamental of all the ways in which we can be influenced by reactions and experiences that occurred in the past. (201-201) According to Rumelhart, schema theory is a concept about knowledge representation and how the representations help us to make use of the information: in the interpretation of sensory data, for retrieving information from memory, and in organizing action and problem-solving. (Rumelhart, 34, 46-57)

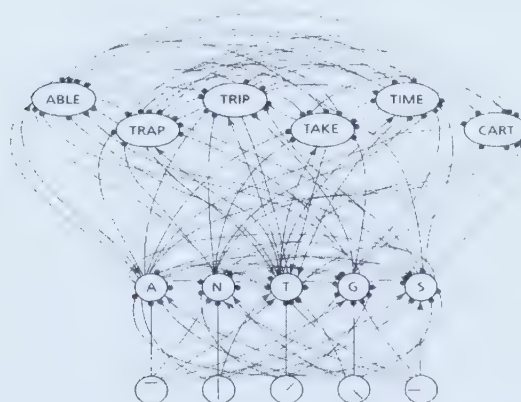
Schema theory is relevant to this study because it describes how we use stored knowledge to act and explains errors as the application of an incorrect schema to an action. (Reason, 1990, 36)

PARALLEL DISTRIBUTED PROCESSING (PDP): AN INTERACTIVE VIEW OF INFORMATION PROCESSING

Rather than looking at information processing as a set of discrete stores that move information back and forth, PDP models describe activity that occurs in the brain as series of interconnected neurons—modules that activate or inhibit by each other, based on whether or not information from one module matches that of another module. Representations of information are spread across modules in complex and changing ways, with the patterns of associations shaping what the system knows and how it will respond. (Lefrançois, 248) McLelland and Rumelhart's interactive activation model demonstrates parallel processing by showing how words are recognized at the feature, character, and word levels as well as having input from higher level of semantic information, making it both a “top-down” (conceptually driven) and “bottom-up” (data driven) system that is working simultaneously. (377, 378)

Figure 8
*Interactive Activation
Model*

Activity occurs in the brain as series of interconnected neurons—modules that excite or inhibit by each other, based on whether or not information matches. Arrows represent excitatory connections, while circles are inhibitory.



(McLelland, Rumelhart, 380)

This model explains that words are recognized by activation at each of the levels, simultaneously, suggesting that the physical features and the visual presentation of the word, in terms of legibility can assist or hinder recognition.

The Framework (cont.)

Models of Word Recognition

In the field of psychology, there are three major categories of models for word recognition; word shape recognition, serial character recognition and parallel character recognition. Visual communication designers, traditionally, acknowledge the word shape model as the way in which words are recognized, whereas, the view most accepted by psychologists who study reading is the parallel processing model. (Larson, ¶15)

Word Shape Recognition

In the first model, words are recognized as a whole unit, rather than as a collection of individual characters. Psychologist James Cattell was the first to explore this model and did so by measuring the speed by which participants recognized words and characters. He found that participants were quicker to recognize whole words than series of single characters. (387, 579) Ascenders, descenders and the variety of strokes in lowercase letterforms help to make words distinctive and easily recognizable while the limited variation of strokes in letterforms set in all uppercase tend to make words too regular. (Carter, Day, Meggs, 89) According to Tinker and Paterson, the reading rate for letterforms set in all uppercase characters is slower, supporting the idea, that word shape is important in recognizing words. (366)

A criticism of this theory of word recognition is that it presumes that we must store thousands of word shapes in our head, both uppercase and lowercase characters, in order to recall words. (Smith, 26,127)

Figure 9

Words set in lowercase characters have a more distinctive shape than uppercase characters.



(Carter, Day, Meggs, 88)

Serial [Character] Recognition

In this theory of word recognition, psychologist, Philip B. Gough proposed that we recognize words, character-by-character, and that we store the characters in STM while we search our lexicons for a match to the word. He bases his model on the speed with which characters are recognized (10- 20 msec) as being in line with the average reading speed of 300 words per minute. (335) The evidence against this model, explained by the word superiority effect, shows that characters that are in the context of a word are more easily distinguished than characters in isolation and suggests that the processing of words and characters occur in parallel. (Reicher, 280)

Figure 10

According to the serial [character] recognition theory, words are recognized character by character.



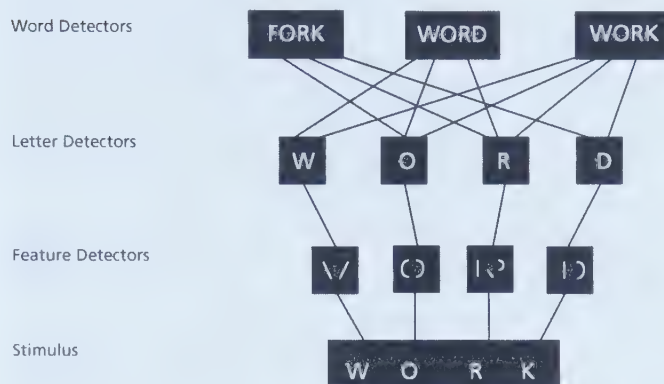
The Framework (cont.)

Parallel [Character] Recognition

The parallel character recognition model explains word recognition as the simultaneous processing of various types of characteristics of the word. McClelland and Rumelhart's interactive activation model of word recognition involves parallel processing at feature, individual character and word levels as well as having input from a higher level of semantic information making it a "top-down" (conceptually driven) and "bottom-up" (data driven) system that works interactively. This model of information processing works by the activation of a series of interconnected neurons. McClelland and Rumelhart explain their model in terms of nodes that connect information about a word. They assume that there is a node at the feature, character and word levels and that the connections are either excitatory or inhibitory depending on whether there is match between them. (377-380)

Figure 11

The interactive activation model of word recognition involves parallel processing at feature, individual character and word levels as well as having input from a higher level of semantic information.



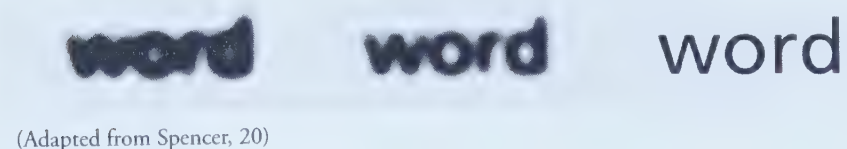
(Larson, 6)

This interactive process explains how we access our lexicon or "mental dictionary." When presented with words, we search our mental lexicons for detailed information about those words: orthographical (spelling), phonological (sound), morphological (meaningful clusters), syntactical (grammatical description) and the semantic (meaning). (Emmorey, Fromkin 124) These representations help us to retrieve the correct words from our memory. Problems occur with words that have lexical similarities which are more likely to be confused. (Lambert, 1162)

Although word shape is purported to be the model to which visual communication designers generally ascribe, typographer and researcher, Herbert Spencer explains that important cues come from the internal pattern created by characters, indicating that features do indeed play a role in word recognition. (20) Professors, Carter, Day and Meggs are in accordance with this view and say that word recognition is based on word shape, and internal word pattern, suggesting that they may in fact agree with the principles of parallel character recognition. (88)

Figure 12

Internal patterns, counters and spaces between characters are important to word recognition.



(Adapted from Spencer, 20)

The Framework (cont.)

Analyzing the Content

Drug Names

The complicated process of developing, testing and marketing a drug takes many years and involves many scientists, private companies, organizations and government agencies that each play a role in bringing a product to market. From chemists, pharmaceutical manufacturers, legal and regulatory organizations, to health care workers and patients, each stakeholder has needs in terms of the name of the drug. When the drug does go to market, it will have gone through many different names that will have served very specific purposes from identifying a substance to creating brand identification. (Boring, 621-634) (See Appendix 1 for a complete list of possible names types, their uses and those who use them.) In the U.S., drug names undergo a rigorous screening process before release to the public, however, names that could pose problems still manage to get through the approval process. (634)

The names that nurses see most often are,

- 1) *The generic name* (common name, proper name, official non proprietary name, international non proprietary name (INN)) and
- 2) *The brand name* (proprietary name, trademark name, trade name).

The generic name usually contains a name stem that indicates the pharmacological class of the drug:

- local anesthetics -caine (Lidocaine, Benzocaine)

Those who develop brand names make use of:

- generic name syllables (Florone® – Diflorasone Diacetate)
- therapeutic action (Azmatrol® – asthma control)
- company name (Sandostatin® – Sandoz Pharmaceuticals)
- route of administration (Topicort® – topical application)
- dosage schedule (Veetids® – t.i.d. (three times daily))
- dosage form (Lortab® – tablet)
- completely unrelated (Xanax® – eye catching palindrome). (Boring, 628)

Three types of confusions that can occur with look-alike/sound-alike names during the medication process. They are:

- confusion with generic names (Cefazolin and Cefoxitin) or
- confusion with brand names (Micronor® and Monacor®) or
- confusion with generic and brand names (Lasix and Losec®).

Look-alike/sound-alike (LA/SA) Names: Managing risk

In 1999, the Food and Drug Administration (FDA) in the U.S. began reviewing proprietary names for new drugs to avoid the risk of name confusions. Pre-market drugs undergo a review that is made up of: an expert panel review, a handwriting and verbal analysis, a computer-assisted analysis, a labeling and packaging analysis and an overall risk evaluation. (Holquist, 36) Post-market, they monitor reports of medication errors that are related to naming labeling and packaging of drugs and where appropriate, have requested that manufacturers voluntarily revise the appearance of their names. The *Name Differentiation Project*, a recommendation to pharmaceutical manufacturers, developed by the

The Framework (cont.)

FDA in the U.S. in 2001, suggests cueing in a part of the name that would help to differentiate it. Their suggestion is a change in case, from lowercase to uppercase characters (for example, Bupropion–BuPRO-Pion and Buspirone–BusPIRone). They provided a list of 16 pairs and a single name to manufacturers involved in the production of those drugs and encouraged them to use this method of clarification. (FDA/CDER, 2002)

Another solution that has been proposed is the use of bar coding the drug and the patient. (CDER) The Health Products and Food Branch of Health Canada is in the process of developing policy for pre-market and post-market guidelines for look-alike/sound-alike health product names. (BGTD, HPFB, 3)

There is no easy way to solve the problem with existing drug names that are prone to cause confusion. The most effective way to resolve name issues would be to change the problem names all together, but because of the investment involved in developing and marketing drugs, it is not possible to change every existing drug name that can, potentially, be confused with another. A visual solution, as proposed by the FDA (using uppercase to differentiate) addresses these limitations and works with factors concerning human attention. This approach is the point of departure for this study, where it is tested, along with other typographic variations, to see if they may help to differentiate drug names to reduce the risk of confusion.

Packaging and Labeling Concerns

Compounding the problem of look-alike/sound-alike drug names is the visual context in which the name appears, specifically, the labeling and packaging of drug products. An analysis of the United States Pharmacopoeia (USP) Medication Errors Database, for reports received between 6/1/96 and 5/31/97, identified labeling and packaging as contributing to medication errors. They cite the following reasons:

- lack of prominent placement of drug name and strength
- small size and poor readability of printed information
- insufficient prominence given to route of administration (e.g., nasal vs. injection, intravenous vs. intramuscular)
- poorly designed or cluttered labels
- lack of differentiation between drug products that have similar names... (USP, 1998)

The FDA, ISMP and JCAHO have suggested strategies for reducing risks in hospitals associated with look-alike/sound-alike drugs that can be applied to labeling:

- differentiate look-alike/sound-alike drug names (Hoppes, 90) (ISMP, 2002)
- use reminder labels/stickers on product containers (Hoppes, 90) (JCAHO, 2001) (ISMP, 2002)
- indicate the purpose of the medication (Hoppes, 90) (JCAHO, 2001)
- provide the generic and brand name on all medication labels. (Hoppes, 90) (JCAHO, 2001)

These concerns are valuable for the development of visual strategies for the design of prototypes intended to help minimize the risk of error by:

- **Accentuating** the differences of look-alike/sound-alike drug names on labeling in order *to engage*,
- **Structuring** the text by providing visual cues, information flags for maximum legibility in order *to guide*, and
- **Incorporating** verbal information that can help identify the medication for maximum readability in order *to inform*.

The Framework (cont.)

Sourcing of Names for Testing

Look-alike/sound-alike drug names used for testing were taken from a number of sources that identified names as either involved in errors or as having the potential to be problematic:

- 1) Institute for Safe Medication Practices (ISMP), Jelincic, V., Pharmacist and Author, searched the ISMP drug error reporting database for recent entries and provided a list, via personal correspondence
- 2) Joint Commission on Accreditation of Healthcare Organizations provides a descriptive list entitled, *Look-alike/sound-alike drug list*
- 3) United States Pharmacopoeia (USP) provides a listing of problem names entitled, *Use Caution—Avoid Confusion*
- 4) Institute for Safe Medication Practices (ISMP, 2003b) reports on a drug pair in the article, *“Looks” like a problem: ephedrine – epinephrine*
- 5) U. S. Food and Drug Administration/Center for Drug Evaluation and Research (FDA/CDER) describes an initiative geared towards manufacturers to help reduce confusion with drug name pairs in, *Medication Errors: Name Differentiation Project*
- 6) College of Pharmacists of British Columbia published some names that had recently been identified in, *Drug Updates*

All names were crosschecked with the *Compendium of Pharmaceutical and Specialties (CPS)* to ensure that the drugs are currently available in Canada.

The Role of Information Design

Information designer, Saul Carliner describes information design as, “a problem-solving discipline that considers more than the appearance of the designed product, but also the underlying structure of the solution and its anticipated reception by users.” He believes that a design theory should help in the preparation of communication products with performance objectives in mind and has developed a *Three-part Framework for Information Design* that helps to meet these objectives. Carliner based his model on the three levels that educational and instructional design theorists take into consideration when designing courses. His process model for designers looks at information design at three levels:

- Affective Level – Helping users perform
- Physical Level – Helping users find information
- Cognitive Level – Helping users understand information (44-46)

One of the strengths of Carliner’s framework, as he points out, is the influence of related fields. He builds on successful frameworks used in educational psychology and instructional design (based on Bloom’s taxonomy of educational objectives), originally conceived of as the affective, psychomotor and cognitive domains. (Bloom, 7) Carliner also acknowledges the influences of other fields, such as software engineering, instructional/educational technology, adult learning theory and business management. (54,

The Framework (cont.)

55) Of note are the parallel categories of human factors that are taken into consideration when developing standards in Human Computer Interaction (HCI): cognitive factors refer to how humans process information; affective factors refer to emotional aspects, values, preferences and satisfaction and physical factors are based on the physiology of humans and include visual and motor skills. (Buie, 40,41)

The purpose of his framework is to provide a plan that outlines the issues involved at each level of design and the procedures involved for technical communicators in the field of document design, encompassing both print and digital media. (41) Though it is geared toward multi-page documents that involve large quantities of text material, many of the design issues delineated are applicable to this study. Using his framework as a basis, this study concentrates on some of the issues that Carliner discusses, especially those that affect a response in the user as a result of the various levels of design.

AFFECTIVE LEVEL OF DESIGN – HELPING USERS PERFORM

The affective level involves designing for emotional impact. To motivate the user it is important to: understand their attitudes and what drives them, capture and maintain their attention and affect a change in their action by understanding the cultural, social and political impact and legal, ethical, and communication issues. (52-54)

PHYSICAL LEVEL OF DESIGN – HELPING USERS FIND INFORMATION

The physical level helps users locate the information. This requires an understanding of how the user perceives visual organization and how this can be affected by the formal aspects of design (legibility and the arrangement of elements in terms of hierarchy, layout, white space, chunking of information and graphic devices). In addition, attention is given to issues of retrievability of information and the selection of appropriate media and production processes. (45-47)

COGNITIVE LEVEL OF DESIGN – HELPING USERS UNDERSTAND INFORMATION

The cognitive level addresses the user's ability to understand and make use of information. In considering human performance and the task at hand, concerns such as cognitive load are addressed by design in terms of minimalism. Content (what must be included/excluded in terms of cognitive functioning and capacity), issues of readability and language used for communication that is appropriate to the genre/user, and the technical aspects of writing³ (following guidelines and regulations) are considered.

³ In Carliner's model writing is included at the physical level. Though this may be especially appropriate for applications that use language to perform complex tasks, such as instructions, in the context of this study, text is especially important at the cognitive level, for understanding.

In this study, Carliner's model will be used in order to develop labels that will reduce errors caused by confusion of drug names by:

- *engaging* the nurses and calling his/her attention to look-alike/sound-alike names by *accentuating* the differences of look-alike/sound-alike drug names on labeling;
- *guiding* them through the various levels of information by *structuring* the text, providing visual cues and information flags for maximum legibility; and
- *informing* them and providing relevant information by *incorporating* text that can help identify the medication for maximum readability.

The Framework (cont.)

Context, content and form are essential elements in the communication of a message. (Swann, 54)
In the context of the drug label, the content is represented by the drug information and the form embodies the typographic attributes and the composition/layout. Designer and educator Ken Hiebert defines content as, “the underlying thought that provides the criterion and stimulus for a form.” (13)
In other words, it is the drug information and its intrinsic structure that will help determine how text should be organized on the label.

Determining Content

Content appearing on the label will be selected based on information required for the medication process that is active in STM or LTM. The tasks include retrieving medications delivered by pharmacy, crosschecking drugs with patient charts, prescriptions, identification bracelets and labels and the administration of those medications to specific patients. Information active in STM is used while performing the tasks and previously rehearsed information. Stored knowledge is accessed from LTM by way of text cues that could help confirm information about the therapeutic uses of a particular medication and the illness in relation to the patient.

In addition to cognitive issues, the selection of content that could aid in the identification of look-alike/sound-alike names is to be determined based on the following:

1) Legally required text legislated by the Pharmaceutical Profession Act (Alberta) includes:

- patient name
- physician name
- pharmacy name, address, telephone
- pharmacists name
- date dispensed
- prescription number
- generic/common name
- dosage form
- dosage strength
- instructions for use (20(1))

2) Additional Information suggested by the Alberta College of Pharmacists:

- brand/trade name
- therapeutic category
- indications
- route of administration
- number of refills
- drug identification number (DIN)
- identity of the manufacturer
- the quantity dispensed
- expiry date (5.1(f))

3) Information that nurses are trained to look for when administering drugs to a patient, known as the “five rights”:

- right drug
- the right patient
- the right dosage
- the right time
- the right route of administration. (ISMP, 1999)

The Framework (cont.)

Composition/Layout

In, *A Primer for Visual Literacy*, author Donis A. Dondis explains that composition is the most important step in visual problem-solving because this is where the designer has the opportunity to set the tone for communication. Though there are no absolutes for the arrangement and organization of elements, the investigation of human perception provides us with an understanding of what will occur in terms of meaning. This comes from a combination of the arrangement of visual elements and the process of seeing. (20)

GESTALT LAWS OF VISUAL PERCEPTION: ORGANIZATION OF FORM

The *Gestalt* school of psychology, formed in 1912 by Max Westheimer, Kurt Koffka, and Wolfgang Kohler provide visual communication designers with explanations for basic perceptual phenomena by investigating the way we perceive and organize form. The guiding principle behind their thoughts is based on the notion that the whole is more than the sum of its parts. In other words, meaning in form, comes from our ability to perceive the organization of the complete form and not individual elements.

For the *Gestalt* psychologists, the law of *prägnanz* or good form is used to describe visual organization. (Koffka, 110) Dondis explains that the use of the word “good” is not a desirable, nor a very accurate term. She believes that “least provoking,” “simplest” and “least complicated” could be considered descriptors that are more accurate. (31) Koffka describes a number of principles of organization, known as the “Gestalt Laws of Perception,” that are used by visual communication designers to organize visual elements in a composition such as: proximity, similarity, continuity, closure and the figure/ground relationship.

Figure 13
Proximity

Objects that are closer to each other than they are to other objects are perceived as belonging together as a group. (164)

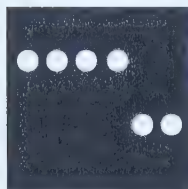


Figure 14
Similarity (Equality)

Objects that are similar to each other are perceived as being related. (165)

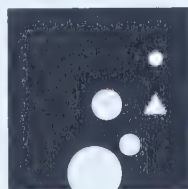
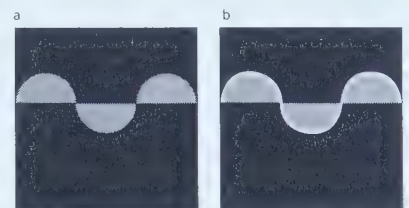
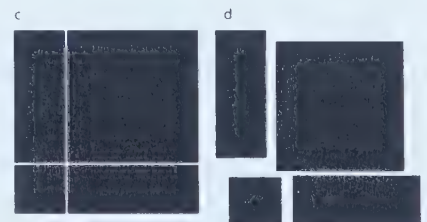


Figure 15 a-d
Continuity

a/b - We are more likely to perceive shapes or forms that are smooth and continuous than ones that are abrupt.



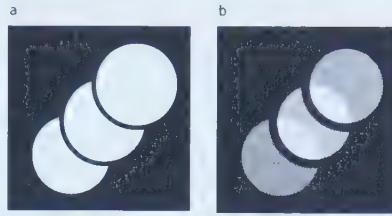
c/d - We tend to extend lines to look for a unified whole, rather than seeing separate shapes. (153)



The Framework (cont.)

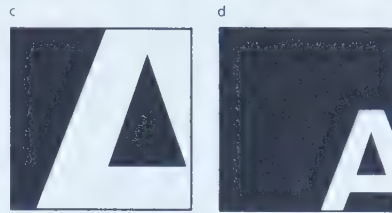
Figure 16 a, b
Closure

We tend to complete forms or close contours. (167, 168) Closed areas seem to be self-sustaining, stable organizations. (15)



Figures 17 c, d
Figure/Ground

We perceive objects based on their relationship to the field they occupy. What we see as figure or ground can be influenced by visual qualities such as the contrast between the two, cropping and the relationship to the frame of reference and the amount of space each occupies. (178-205)



These observations of human perception explain how the formal aspects of design can help in the communication of a message. They provide the designer with guidelines that are useful in the organization of visual information.

CREATING HARMONY: CONCORD AND CONTRAST

The harmonious arrangement of elements in a composition can attract the attention of the viewer, help them navigate through the visual field and provide crucial information required for decision-making. John Bowers, articulates harmony in composition as, “a grouping of related components that make sense together.” (69) This is achieved by balancing form (typographic elements) and ground (white space); elements complement and compensate for each other to create unity and equilibrium. (Carter, et al., 54) Harmony between typographic elements at the character, word, sentence, paragraph and story levels of text is accomplished by concord and/or contrast of these components.⁴ Concord strives to provide uniformity while contrast serves to punctuate, draw attention to and clarify by placing elements in opposition to each other. (Dair, 49, McCreight, 48). Carl Dair relates the meaning of contrast in typography by comparing it to the world around us,

“We understand the surroundings in which we live through contrast; all of our senses react to contrast. We understand shadow because we know about light; differences in qualities are measured by contrast; soft and hard, sweet and sour, rough and smooth, cold and warm, light and heavy. Our senses are trained to detect the differences between things in the world about us.”

⁴ The typographic elements on the labels in this study can be more accurately described as “words” and “phrases,” rather than as “words” and “sentences.”

The Framework (cont.)

Elements that can be manipulated to achieve concord or contrast in typographic design are:

- 1) placement (horizontal, vertical, diagonal)
- 2) alignment (flush left, ragged right, centred, flush right, ragged left, justified, asymmetric);
- 3) line, word and character spacing
- 4) typographic qualities or characteristics (style: serif, sans serif, decorative; character width: condensed, regular, extended; size: x-height, cap height or body size; case: uppercase, lowercase, small caps; weight: light, medium, bold; stance: roman, italic; and character spacing: proportionally or monospaced)
- 5) colour (achromatic, monochromatic, chromatic)
- 6) texture

While typographic choices are key, the manner in which the type is placed in a visual field must engage, guide and inform to enable effective communication. In his book, *Grid Systems in Graphic Design*, Josef Müller-Brockman maintains that,

“Information presented with clear, logically set out titles, subtitles, texts, illustrations and captions will not only be read more quickly and easily but the information will also be better understood and retained in the memory.” (13)

Grids provide an underlying framework that organize and unify typographic elements within a composition. The systematic divisions in a grid provide spatial zones for the orderly placement of information. A hierarchy is established when the designer identifies all part of a message and assigns specific zones. (Carter, Day Meggs, 70) This results in consistency in placement that promotes predictability, an important factor for accessibility.

ESTABLISHING A HIERARCHY

A visual hierarchy expresses the relative importance of elements in a composition/layout. It organizes the components by establishing relationships; elements with similar characteristics tend to have equal importance, while elements that have contrasting characteristics are viewed as having a dominant/subordinate association. Typographic contrasts, the location of elements and their spatial relationships influence the relative importance of elements in an arrangement. (Carter, et al., 58)

Hierarchy of text elements or components helps the reader navigate through a composition, signaling where one should enter and exit. The viewer is made aware of the relative importance of the elements through the use of visual cues. (Lupton, 2004, 94)

Establishing a strong hierarchical structure is important in trying to capture and maintain the attention of the viewer and to help them navigate through information that is critical for understanding.

FACILITATING MEANING: VISUAL CUEING

Along with helping to establish hierarchy in an arrangement, the cueing of text is used to facilitate meaning. This can be verbal, visual or a combination of both. Verbal cues signal the structure of the text with words such as, “first,” “next,” “finally,” while visual or graphic cues can complement or replace verbal cues (as cited in Gilreath, 342, Bernhardt, 1986 and Hartley, 1985). The words “first”

The Framework (cont.)

or “second” can be replaced by a number or with a bullet or other visual devices. Studies of the effects of typographic and spatial cueing show that this method of organizing a layout can facilitate comprehension of text for various types of reading strategies: careful serial reading, searching, surveying, browsing, and skimming. (Gilreath, 342) This is demonstrated in separate studies that look at typographic and or spatial cueing with some success. Among these are the use of:

- weight and typeface to establish hierarchy in text; (Garofalo)
- headings to aid in recall, search and retrieval tasks; (Hartley and Trueman)
- meaningful segmentation of information using spatial cues; (Fraser and Schwartz)
- uppercase characters in relevant text to facilitate recall. (Foster)

Researcher, Charles T. Gilreath proposes a new taxonomy for classifying graphic cues and divides these into two categories, typographic and diagraphic cues. Typographic cues are based on the qualities inherent in the design variations of a family of type (with the exception of the underline, which is a type of graffix, the graffix⁵ and reversing of type). Diagraphic cues are further subdivided in to space and mark cues. Space cues refer to the white or blank space around visual elements, such as indents, line spaces, column spaces or can be space that is toned with colour or texture, and mark cues are graphic signs or lines that help to organize text (344-350) Used in conjunction with the verbal cues, the meaningful or natural breaks that occur in text, these cues can act as emphasis to text that can benefit from highlighting in order to facilitate understanding.

⁵ “Graffixes’ are marks attached to words for highlighting purposes. ‘Graffix’ is a blend of the words graphic and affix.” (346)

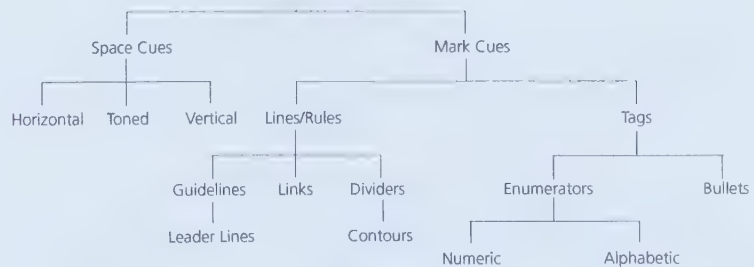
Figure 18
Graphic Cues

A taxonomy for classifying graphic cues divides them into two categories: typographic and diagraphic cues.

Typographic Cues

Cue	Attribute	Example
Boldface	weight	boldface
Italics	[stance]	<i>italics</i>
Underline	marking	<u>underline</u>
Uppercase	case	UPPER CASE
Typestyle	style	times roman
Type Size	size	smaller
Colour	colour	black
Reverse	background	reversing
Graffix	marking	[graffix]

Diagraphic Cues



The Framework (cont.)

Unity and clarity in composition/layout are crucial to successful communication. This can be achieved by taking into consideration observations of human perception as it applies to organization of form, harmonious relationships through concord or contrast of typographic elements, and the importance of hierarchy and visual cueing to establish and reinforce meaning.

Typography

Carter, Day and Meggs state that the qualities inherent in typography make type legible. (85) In order to communicate with ease the designer must strive for clarity of the typographic forms and attention to their spatial arrangement in the specific context.

LEGIBILITY AND READABILITY: A PSYCHOLOGY PERSPECTIVE AND A DESIGN PERSPECTIVE

The typographic choices for the prototypes are based upon research literature and documented typographic conventions related to legible and readable text. Depending on the discipline that is studying them, legibility and readability can be defined in different ways.

Ellen Lupton, author, researcher and design educator, defines legibility and readability from both the point of view of both the designer and scientist,

“Legibility concerns the ease with which a character or word can be recognized (as in an eye exam), whereas ‘readability’ describes the ease with which a text can be understood (as in the mental processing of meaningful sentences). Designers often distinguish “legibility” and “readability” as the objective and subjective sides of typographic experience. For scientists, however, readability can be objectively measured, as speed of reading + comprehension. (2003)

The book, *Legibility of Print*, by psychologist and researcher, Miles A. Tinker, provides a slightly different but more complete definition. He defines legibility and readability as follows,

“Optimal legibility of print...is achieved by a typographical arrangement in which shape of [characters] and other symbol, characteristic word forms, and all other typographical factors such as type size, line width, leading, etc., are coordinated to produce comfortable vision and easy and rapid reading comprehension...(8). ‘Readability formulas,’ [have been] devised to measure the level of mental difficulty of reading material.” (4)

In this study, the term ‘legibility’ is used in relation to the formal aspects of typography, while the term ‘readability’ is used in relation to content, and the level of language used to impart a message. Both legibility and readability go hand in hand for effective communication of a message.

The Framework (cont.)

LEGIBILITY RESEARCH

Psychologists have conducted experiments in legibility of printed materials since the late 1800's. Tinker's 1963 book, *Legibility of Print*, summarizes empirical research to date. The findings are based on studies that examine the specific characteristics of typefaces (style, size, line length, etc.) in settings that affect the legibility. The major limitation of these studies (as with any study involving specific variables) is that most of them were concerned with continuous text as opposed to short "chunks" of text. Ellen Lupton discusses the validity of scientific research studies into legibility,

"Each study isolates and tests certain variables (font style, line length, screen size, etc.). Although rational and scientific, this process is also problematic, as typographic variables interact with each other—a pull on one part of the system has repercussions elsewhere." (2003, ¶3)

Though limited in their applications, these studies can be used as a point of departure for the testing of formal characteristics of typographic composition within specific contexts. In 1969, Herbert Spencer, the author of *The Visible Word: Problems in Legibility*, evaluated legibility research, beginning with the first experiment in 1790 (he included Tinker's work along with a number of other psychologists who conducted legibility studies over the previous 100 years) and summarized the findings for designers. These studies provided the basis of further research in the 'Readability of Print Research Unit' at the Royal College of Art in London, where he and his colleagues, Linda Reynolds and Brian Coe conducted experiments with very specific types of communications materials, such as bibliographic entries. These studies dealt with legibility on the basis of single characters, single words and small groupings of text, often for specific genres. In and of themselves, the studies are useful because they provide insight on the performance of typographic variations in similar contexts in which they would ultimately be read.

Generally speaking, practicing designers are suspicious of legibility studies, as pointed out by designer and columnist for *Graphis* magazine, Rick Poyner. He states that, "The findings of legibility researchers have...never been particularly welcomed by designers...[T]he scientific approach seems fundamentally hostile to the mysteries of the creative process." (1999, 14) In another article he scorns the claims made by designers, in the early 1990's on "the optimum way to communicate in the digital era" (because these claims were based on intuition) and comments on the subsequent infiltration of web developers that stressed usability from an engineering perspective. With this, he acknowledges the need, brought on by the Internet for the return of research, "in a big way." (2003, 124) Ellen Lupton has a similar opinion and offers an explanation as to why this direction towards testing has occurred.

"A model surfaced at the end of the 1990's, borrowed...from human-computer interaction (HCI) studies and the fields of interface and usability design. The dominant subject of our age has become neither reader nor writer but user, a figure conceived as a bundle of needs and impairments—cognitive, physical, emotional. Like a patient or child, the user is a figure to be protected and cared for but also scrutinized and controlled, submitted to research and testing." (2004, 73)

Stine Hedegaard Jorgensen, consumer-research consultant describes this new perspective that has emerged in design over the last 20 years as a human-centred approach and explains that it is due to the transition from an industrial society to a global knowledge society and the necessity to gain insight

The Framework (cont.)

⁶Because of the exploratory nature of this study, testing was conducted with a limited number of participants and took place in an office setting in order to avoid disruption.

into the needs, values and desires of users. (24) Ideally, this approach involves testing design solutions on the end user (nurses), in their environment (acute care hospital), while performing tasks⁶. This can serve as a means of exploring the effectiveness of designs that are developed on the basis of legibility studies and experience.

FORMAL CHARACTERISTICS AFFECTING LEGIBILITY: SELECTION OF TYPOGRAPHIC VARIATIONS

Early studies on legibility have, served successfully as the basis for many of the conventions used in visual communication design. The studies conducted by Tinker and other psychologists, Spencer and his colleagues and experience of other experts in the field of typography, will serve as a point of departure for the prototypes and will be explored for their effectiveness through user testing. It is important to note that although legibility studies have provided valuable information which has been used by designers and typographers for some time, they cannot be generalized with certainty, to an application that contains discrete lines of text, as in this study, but they can be used as a guide in the development of prototypes.

The typographic variations for testing will be selected based on, typeface design, typestyle (serif or sans serif), weight, case, stance, size, character spacing and alignment. These attributes will be examined for legibility and capacity to create emphasis.

Typeface

Typographer, educator and author, James Craig, explains that legibility is affected by the forms and shapes inherent in the design of the typeface. He also believes that typefaces closely modeled on basic letterforms are more legible than typefaces that are condensed, expanded, embellished or abstracted. (98) Alan Haley, Creative Director at *Monotype Imaging*, believes that there are three aspects in the design of a typeface that affect the legibility. A typeface should: first, be transparent to the reader and not command unnecessary attention; second, display big features such as sizeable, open counters (See Figure 19), large x-heights and easily recognizable character shapes and third, be restrained in weight, stroke modulation and where applicable, in their serifs. (93) Another factor to consider in selecting a typeface is whether or not it belongs to an extended family that includes a range of designs (various weights, italics, small caps, etc.) that will allow for adequate hierarchical organization.

Figure 19
Counters are the areas in letterforms that are fully or partially enclosed.

bat

Typestyle: Serif versus Sans Serif

A serif typeface is characterized by a small finishing stroke at the termination at the top or bottom of the main strokes in contrast to sans serif typefaces, which have no additional embellishments. The debate about whether serif typefaces are easier to read than sans serif typefaces has been going on since the earliest studies on the legibility of type. Those who believe that serif typefaces are more legible claim that serifs act as cues to help guide the reader's eye across lines of type. They also claim that the serifs add

The Framework (cont.)

definition to the characters, making them more distinguishable. (Carter, Day, Meggs, 88) Haley claims that because sans serif typefaces have simpler character shapes, they are slightly more legible. (97) Others believe that familiarity with one or the other, plays a more important role along with other typographic features such as size, leading (linespacing), line length, etc. (Carter, Day, Meggs, 88)

Paterson and Tinker conducted a study with college students who were shown continuous text in a range of typestyles: a series of serif typefaces, a blackletter typeface, a sans serif typeface and a (proportionally spaced) typewriter typeface and were tested on speed of reading. The results revealed that, though the serif typefaces performed slightly better than the sans serif typeface, the difference was not significant enough to conclude that serif typefaces are more legible. (609) They suggested that if people were more accustomed to reading sans serif typefaces, they might prove to be slightly more legible. (612)

In a more recent study conducted by De Lange, et al. (1993) with primary school students, a serif (Times Roman) and a sans serif (Helvetica) were tested in a word recognition test, a speed reading test, a comprehension test and a scanning test. They found that both typefaces were equally legible. Though they qualify their results by saying that the study “cannot be generalized to a wider population,” they believe that “readers older than the subjects will not find typefaces with serifs more legible than those without.” (243, 246)

Figure 20
A serif typeface is characterized by a small finishing stroke at the termination at the top or bottom of the main strokes.

Serif Sans Serif

Character Weight: Light, Medium, Bold

Character weight refers to the thickness of the stroke or line used to construct a typeface. Most typeface families (other than decorative typefaces) include, along with a regular weight, light and bold versions and sometimes, extra light and extra bold. Used with discretion, bold type can be used to accentuate material in continuous text applications. Research by Paterson and Tinker (as cited in Tinker, 1963) showed that there was “no difference in speed of reading boldface and ordinary lowercase type.” (62) He also notes that Roethlein showed (as cited in Tinker, 1963) “letters in boldface were perceived at a greater distance than ordinary lowercase [characters].” (62) Care should be taken in selecting an appropriate stroke weight because with very heavy stroke widths, counters (enclosed or partially enclosed negative space in a letterform) tend to fill in, while extremely light strokes tend to blend in with the background, reducing the legibility of text. (Carter, et al., 91)

Figure 21
Character weight refers to the thickness of the stroke or line used to construct a typeface.

Light Medium Bold

The Framework (cont.)

Character Width: Condensed, Regular, Expanded

Character width refers to the horizontal proportion of a typeface. As with character weight, using typefaces with extreme proportions (especially extra condensed and extra expanded) are not as legible as typefaces with a regular character width for lengthy reading materials. (Rüegg, 27) Condensed typefaces, while conserving space, tend to have a vertical stress that can disrupt eye movement. (Carter, Day, Meggs, 91)

Both expanded typefaces and condensed typefaces have exaggerated counters, upsetting the balance in the form/counter form relationship, essential for ease in reading.

Figure 22
Character width refers
to the horizontal propor-
tion of a typeface.

Condensed
Regular
Expanded

Case: Uppercase versus Lowercase

Uppercase, capitals or majuscules refer to the large characters in a font, while lowercase or minuscules are the small characters in a font. Text set in uppercase characters slows the speed of reading more than any other typographic factor. (Spencer 1969, 30) Legibility suffers in all uppercase settings because of the absence of visual cues. There is a lack of diversity in character design and no variation in character height which is in contrast to the distinct design of lowercase forms with ascenders and descenders providing a variety of shapes. (Carter, Day, Meggs, 89) In Tinker and Paterson's investigation of uppercase versus lowercase set as continuous text, the lowercase was read 13.4% faster than the material set in all uppercase characters. In their discussion of the results, they noted that this may have been due to: the fact that an all uppercase setting occupies more space, resulting in more fixation pauses; the total word form of lowercase being more distinct than words printed in all uppercase; and text set in all uppercase being less familiar for the reading of continuous texts than lowercase characters. (366-367)

Figure 23
Uppercase, capitals or
majuscules refer to the
large characters in a
font, while lowercase or
minuscules are the small
characters in a font.

UPPERCASE
lowercase

Stance: Roman versus Italic

"Stance" or "posture" of a typeface is the slant or angle that the typeface leans, in relation to the baseline. (Griffie, Casey, 209) True italics or "cursives" are not merely a slanted version of the roman counterpart, but distinct, typefaces that have the flowing qualities of handwritten text. An oblique, on the other hand, is a typeface that is a mechanically sloped version of the roman. If the slope is

The Framework (cont.)

too severe, there is distortion in the stroke widths (verticals become thinner, while horizontal strokes remain the same), resulting in thick areas where horizontal and vertical strokes meet. In the last two hundred years, many of the “italics” that have been designed are hybrids. Originally designed for continuous reading, italics are most often used to emphasize individual words. (Bringhurst, 57) Research concerning comparisons of continuous text, conducted by Tinker in 1955 and reported in his book, *The Legibility of Print*, showed that participants read roman lowercase text faster than italics by a small, but significant amount (15.5 words per minute faster). This difference, combined with comments from participants that they didn’t like reading text set in all italics, led Tinker to conclude that italics should be used on “those rare occasions when added emphasis is needed.” (Tinker 55, 56) Opinions and advice from designers vary on this matter. Spiekerman believes that a designer should be open to using italics for continuous text treatments. He claims that it is possible that roman versions are more legible because we are more accustomed to reading roman than italic texts, while Craig recommends using italics “mainly for quiet emphasis.” (Spiekerman, 63)(Craig, 15)

Figure 24
“Stance” or “posture” of
a typeface is the slant
or angle that the typeface
leans, in relation to
the baseline.

roman
italic
oblique

Type Size

When following published studies, guidelines, or recommendations for type size, the design of the typeface must be taken into consideration, especially when substituting for a typeface other than the one tested or recommended. The same is true for cap height size versus body size/point size; not all typefaces have equal cap heights at the same point size. For text set in both uppercase and lowercase, measuring by x-height size is more accurate for comparisons than body size and similarly, for text set in all uppercase, measuring by cap height size is more accurate for comparisons than by body size.

Figure 25
Upper and lowercase
characters from three type-
faces set at the same point
size show that not all
typefaces have equal
x-heights or cap heights.

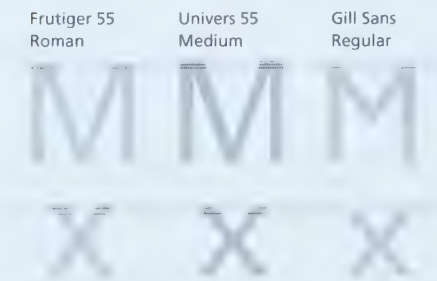
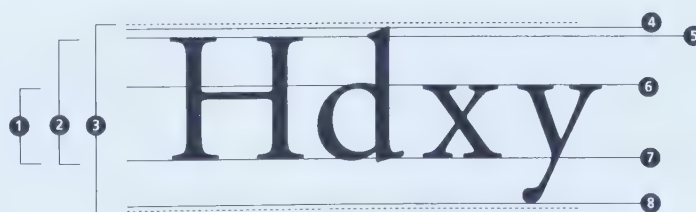


Figure 26
1. x-height
2. cap height
3. body/point size
4. ascender line
5. cap height line
6. x-height line
7. baseline
8. descender line



The Framework (cont.)

Most studies that examine type size and legibility for print applications are based on speed and comprehension and are specific to continuous text applications. For example, the optimal type sizes of continuous text type, for maximum legibility, are mentioned in Herbert Spencer's, *The Visible Word*. He reports that type sizes between 9 and 12 point are more or less equally legible. (1969, 35)

Experiments conducted by Poulton are more applicable to this study because the testing material used was a listing of words (not sentences or continuous text) – a closer approximation of the testing material used in this study. In comparing size, style and vertical spacing with typefaces Univers, Times and Perpetua, Poulton wanted to determine the minimum, legible size for lists of food ingredients. He averaged the number of ingredients participants found in each case, comparing the numbers for each of the typefaces and type sizes and found that the minimum size of lowercase characters should not measure less than 1.2 mm. Using x-heights that are optically equal in size, this translates to 6.5 point type for both Univers and Times and 8.5 point for Perpetua. In addition, he found that 1.4 mm cap height was the minimum size for all uppercase type set in Univers. (156-161)

Figure 27

At the same body/point size, some typefaces have significantly smaller x-heights, relative to their cap-heights, making the typeface appear smaller in comparison to other typefaces at the same point size.

This is Univers at 18 point.
This is Times at 18 point.
This is Perpetua at 18 point.

This is Univers at 6.5 point.

This is Times at 6.5 point.

This is Perpetua at 8.5 point.

Character Spacing: Proportional versus Monospaced

The characters in monospaced typefaces each occupy the same space horizontally, regardless of the width of the character (based on the measurements used for typewriters; pica=12 per inch and elite=10 per inch) whereas the spacing between characters in proportionally spaced typefaces is based on the form of individual characters and their relationship to other characters. In a monospaced typeface, this forces the character "i" to occupy the same amount of space as much wider characters such as "w" or "m." (Spiekerman, 125) The effect is much smaller counters in the wider characters, making them look very condensed in comparison to the other characters. This results in very little space around wider characters and an abundance of space around thinner characters. When combined, the unequal spaces between them interrupt the consistent rhythm that the positive and negative spaces should provide. In proportionally spaced typefaces, the attention to equalizing the space around each character eliminates interruptions, making proportionally spaced typefaces generally easier to read than monospaced typefaces.

Figure 28

With monospaced typefaces (left) each character occupies the same space horizontally, while with proportionally spaced typefaces (right), spacing is based on the form of individual characters and their relationship to other characters.



The Framework (cont.)

In, *Readability of Typewritten Material: Proportional Versus Standard Spacing*, Donald E. Payne reports on a study that was concerned with how the differences in spacing and character width in proportional and [monospaced] typefaces affected the legibility and readability of continuous text materials. Reading speed and comprehension scores were compared. Text set in the proportional typeface was read significantly faster, without losing comprehension. (134)

Typically, monospaced typefaces such as Courier or Letter Gothic are used for hospital prescription labeling because of technological and cost constraints (dot matrix or ink jet printers are commonly used). Technological improvements have resulted in better printing and a wider selection of well designed, proportionally spaced typefaces, that result in clean, sharp, legible text. With the cost of inexpensive laser printers, and the availability of a wider range of typefaces that are now standard on new computer systems, the use of proportionally spaced typefaces is feasible.

Figure 29

Typically, hospital
pharmacies use mono-
spaced typefaces for
medication labeling.

BUSPIRONE 5mg
(1/2 x 10mg)
Generic for "BUSPAR"
Control #003 (pms)
Exp: 05/02

Type Alignment:

Justified, Flush Left, Flush Right, Centred, Asymmetrical

Type alignments help to structure and create order in a composition. The traditional alignment used for continuous texts is the justified setting. (Carter, et al., 56) However, type that is set flush left, ragged right promotes greater legibility because word and character spacing are at their optimum, unlike justified settings where the word space can vary from line to line because the text is forced to particular measure. An advantage of having lines of unequal length is that it allows the text to be broken according to the meaning of the text, rather than forcing words to a specific line length. (Carter, et al., 93) Though optimal word and character spacing is also evidenced in flush right, ragged left, centred and asymmetric settings, the absence of a common starting point on the left side of the text forces the reader to work harder to find the next line. (Craig, 104-107) These factors may have contributed to the results of Zachrisson's experiment on the effect on legibility of unjustified setting that showed that flush left text was read more quickly than justified text in (as cited in Spencer, 1969, 37).

Creating Emphasis:

Contrast in Style, Weight and Typefaces

Herbert Spencer conducted a study entitled, *A comparison of the effectiveness of selected typographic variations*, where he compared the relative effectiveness of distinctions between the typographic variations of type style, type weights and typefaces. In testing for style, he chose three distinctly different groups: serif, slab serif and sans serif. The typefaces used were Goudy and Times in the serif category,

The Framework (cont.)

Fortune Light and Rockwell Medium in the slab serif category and Univers and Futura in the sans serif category. Two different weights were tested for each typeface—medium and bold. He exposed participants to familiar five-character words in a non-contextual format and asked them to:

- 1) rate the difference in a paired exposure;
- 2) rate the difference in a sequential exposure; and
- 3) arrange the words in visual pairs.

The results of his experiments suggest that differences in weight are more effective than differences in type style or typeface. His results also indicated that style and typeface differences are noticeable and that style differences are still noticeable in combination with a weight distinction but they are relatively insignificant.

Analysis

Following is an analysis of the causes of medication error, based on Reason's Accident Causation Model, which helped to identify where errors occur and where information design might help minimize medication errors. In addition, is an analysis of an on-site visit to an acute care hospital that examines the physical environment in which drug name confusion can occur. Specific areas such as the storage of drugs and the labeling on shelves, refrigerators, bins, trays, containers and packages were analysed, visually, to help identify problem areas and error producing conditions.

Analysis (cont.)

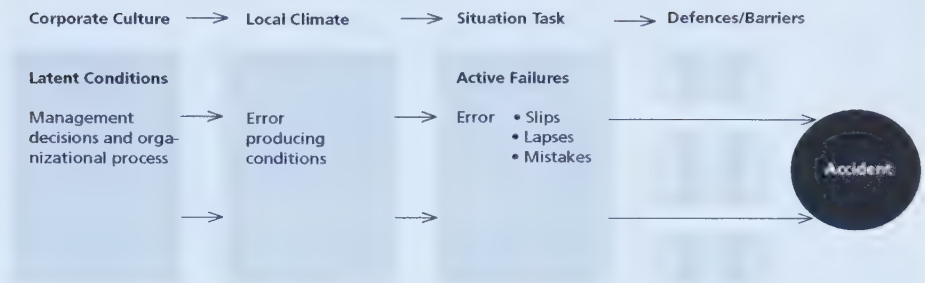


Figure 30
Reason's Accident Causation Model Analysis

Reason's model of accident causation helps to identify problem areas across the system and helps determine specific areas that would benefit from information design. This study is concerned with the areas highlighted in white.

Organizational Factors

- Decisions regarding
 - Workplace design
 - Planning policies
 - Administration/finance
 - Incentives/leadership
 - Supply management
 - Hand-off/transfers
 - Supervision/feedback
 - Unfamiliarity with tasks
 - Mismatch of personnel

Human Factors

Individual

- Physical
 - Fatigue
 - Hunger
 - Unwell
- Emotional
 - Low Morale
 - Poor Motivation
- Hostility
- Cognitive
 - Performance deficit
 - Knowledge deficit
 - Lack of training
 - Miscalculation
 - Misinterpretation
 - Time shortage
 - Miscalculation

Team

- Poor communication
- Supervision
- Responsibility/power/control
- Inadequate staffing

Environment

Physical Environment

- Lack of space
- Poorly organized space
- Shortage of storage space
- Poor or no labeling on shelving

Task

- Slip
(attentional failure)
 - Distraction

- Lapse
(memory failure)
 - Distraction

- Mistake
(inadequate or poorly implemented plan)
 - Poor judgement
 - Using heuristics
 - Logic Error
 - Not following routines/protocols
 - Unfamiliarity with tasks

Analysis (cont.)

Figure 31
Shelf storage of medications in a hospital pharmacy

Potential error producing conditions:

- medications are shelved alphabetically from left to right and top to bottom



Figure 32
Shelf storage of medications in a hospital pharmacy

Potential error producing conditions:

- look-alike/sound-alike drug names
- stored side-by-side
- same manufacturer
- similar package, label



Analysis (cont.)

Figure 33

Hospital pharmacy transferring system: Patient specific trays are filled with medications, placed into a trolley and sent to nursing units

Potential error

producing conditions:

- trays are placed in close proximity while being filled with medications
- unit-dose medication packaging looks similar

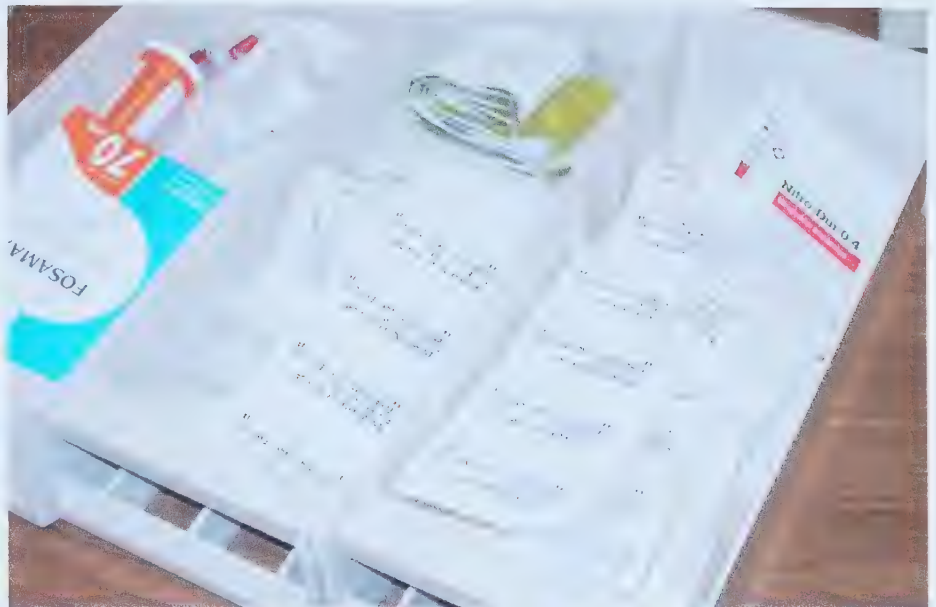


Figure 34

Bin storage of medications in a hospital pharmacy

Potential error

producing conditions:

- amber coloured ampoules with same the packaging
- loose storage in bins and placed in close proximity to other amber ampoules



Figure 35

Shelf storage of stock medications in an oncology nursing unit

Potential error

producing conditions:

- no system for storing medications on shelves
- in some cases there are multiple medications in one tray



Analysis (cont.)

Figure 36
Refrigerator storage of stock and patient specific medications in an oncology nursing unit

Potential error producing conditions:

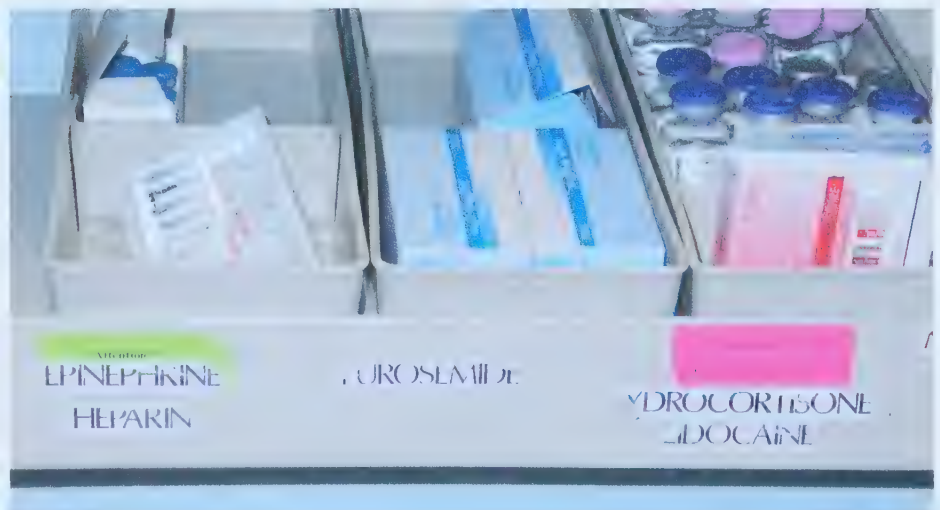
- no system for storing medications in refrigerator
- multiple medications in one tray
- trays are stacked



Figure 37
Shelf storage of stock medications in a nursing unit

Potential error producing conditions:

- multiple medications in one tray
- shelf labels peeling off
- character spacing on labeling, too tight look-alike/sound-alike drug, epinephrine



Analysis (cont.)

*Figure 38
Plastic Packaging
for I.V. Bags*

*Potential error
producing conditions:*

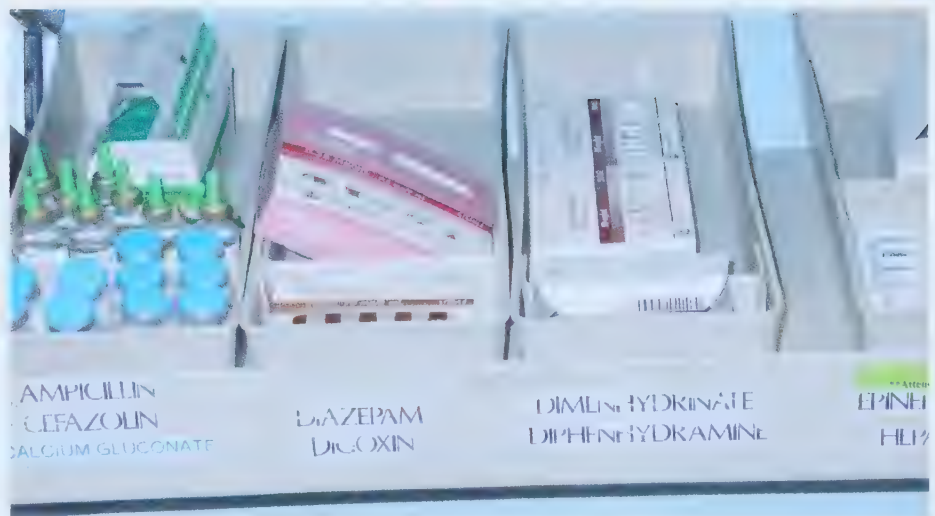
- double bagging with translucent plastic obscures drug information
- similar packaging, same colours



*Figure 39
Shelf storage of stock
medications in a regular
nursing unit*

*Potential error
producing conditions:*

- characters scratched on shelf name label of look-alike/sound-alike drugs, dimenhydrinate, diphenhydramine
- character spacing on labelling, too tight on look-alike/sound-alike drugs,
- look-alike/sound-alike drugs, stored in the same tray



The Design Proposal

The cognitive processes involved in the tasks leading up to the administration of medications include: attention, short-term/working memory and long-term memory. Errors occur when latent conditions (management decisions) cause error producing conditions and are combined with active failures on the part of the nurse. These are either unintended actions (slips, lapses) or intended actions (mistakes). Many of the tasks involved are automatic processes, procedures that have been learned and stored in memory as schemata and are applied to a task when necessary. With slips and lapses, there is a break in attention or a memory failure while performing the procedure. In the case of mistakes, there is a misapplication of a particular schema or procedure. Both can result in error.

The design of the labeling is intended to work by intervening during these cognitive processes by examining the nurse's motivation and attention, perception, and understanding.

Affective Level of Design – Helping users perform

The affective level involves designing for emotional impact. To motivate the user it is important to understand their attitudes and what drives them, capture and maintain their attention and affect a change in their action by understanding the cultural, social and political impact and legal, ethical, and communication issues. This may be achieved by:

- **Accentuating** the differences of look-alike/sound-alike drug names on labeling in order *to engage*, taking into consideration, *motivation and attention*.

Physical Level of Design – Helping users find information

The physical level helps users locate the information. This requires an understanding of how the user perceives visual organization and how this can be affected by the formal aspects of design (legibility and the arrangement of elements in terms of hierarchy, layout, white space, chunking of information and graphic devices). In addition, attention is given to issues of retrievability of information and selection of appropriate media and production processes. This may be achieved by:

- **Structuring** the text by providing visual cues and information flags for maximum legibility in order *to guide*, taking into consideration, *perception*.

Cognitive Level of Design – Helping users understand information

The cognitive level addresses the user's ability to understand and make use of information. In considering human performance and the task at hand, concerns such as cognitive load are addressed by design in terms of minimalism. Content (what must be included/excluded in terms of cognitive functioning and capacity), issues of readability and the language used for communication appropriate to the genre/user, and the technical aspects of writing (following guidelines and regulations) are considered. This may be achieved by:

- **Incorporating** verbal information that can help identify the medication for maximum readability in order *to inform*, taking into consideration, *understanding*.

Objectives

Primary Objective

Help minimize medication error caused by confusion of drug names

Secondary Objectives

Helping users perform

Helping users find information

Helping users understand information

Tertiary Objectives

Engage nurses by calling attention to look-alike/sound-alike names

Guide nurses through the various levels of information

Inform nurses and provide relevant information

Strategies

Level of Design

Affective

Physical

Cognitive

Issues to Address

Motivation and attention

Perception

Understanding

Information Design Strategies

Accentuate information by:

Making the label visually distinct, or novel

- using contrast to differentiate drug names by changing to:
 - uppercase
 - boldface
 - white type on a black rectangle (change in figure/ground relationship)

Emphasizing relevant items

- highlighting drug names by using a larger type size
- positioning drug name prominently, at the top and surrounding it with white space to isolate it
- occupying a substantial amount of space for key drug information (nameplate occupies 40% of the label space)

Structure information by:

Addressing legibility issues

- selection of the typeface (Frutiger family) based on the attributes:
 - typestyle (sans serif)
 - character weight (light, medium and bold)
 - character width (regular)
 - case (mixed, upper and lowercase)
 - stance (Roman)

Establishing a hierarchy

- assigning levels of importance by the use of visual cues such as:
 - weight change
 - size change

Organizing elements

- using the gestalt laws of visual perception, and specifically:
 - similarity
 - proximity
 - closure
 - continuity
 - figure/ground
- using harmony, concord/contrast
- using a grid
- alignment of text
 - flush left, ragged right
- using visual cueing
 - chunking of text
 - spatial cues
 - mark cues (lines/rules)

Incorporate information by:

Working with required content

- legally required items
- items commonly used for double-checking ("five rights")

Including memorable content

- discretionary inclusion of recommended supplementary text such as:
 - both generic and brand names
 - therapeutic class
 - DIN number

Applying visual cueing

- chunking information by limiting to 9 items
- applying meaningful line breaks
- applying typographic, spatial, mark cues (lines/rules)

Differentiating drug names for readability

- using contrast to differentiate drug names by changing to:
 - uppercase
 - boldface
 - white type on a black rectangle (change in figure/ground relationship)

The Design Proposal Prototype Development (cont.)

As noted by Swann, context, content and form are essential elements in the communication of a message. In the context of the prescription drug label, generated in a hospital pharmacy, information design will address the content (drug information) and form (typography and the composition/layout).

Accepting that errors will occur, the prototypes in this study were designed to help minimize the incidence of error and by taking into consideration the affective, physical and cognitive strengths and/or limitations of acute care nurses.

Affective Level of Design – Helping users perform

IMPROVING WORKING CONDITIONS

The culture of healthcare and nursing is one of nurturing, dedication and commitment. But, because nurses are under a great deal of stress and working under less than ideal circumstances, they are taxed intellectually, physically and emotionally. The culture of blame surrounding errors, described by James Reason that has, until recently, been the norm, can leave nurses feeling unmotivated and powerless on the job.

In order for nurses to feel relevant and effective in their work, they must be provided with support and encouragement. This can be achieved by acknowledging that nurses are human and therefore, can and will make errors. Nurses might feel motivated and empowered if there is an attempt to improve their working conditions by designing environments and tools with their strengths and limitations in mind.

Engaging and maintaining the attention of the nurse throughout the medication process is critical to help avoid errors. Because attention is selective and subjective, the nurse must have an interest in what is presented in order that it comes to his/her attention. In a supportive environment, as described above, a nurse might be more attentive to potential problems that could occur with look-alike/sound-alike drug names.

VISUAL DISTINCTIVENESS

Rune Pettersen notes that our information processing resources are limited, so we process and store only what we have paid attention to and not what we have ignored. He notes that, attention span is short, so maintaining it long enough in order that the information is processed and meaning is assigned, is key. According to Pettersen, an information designer has the ability to influence the viewer by using various visual strategies. Engaging and maintaining attention for further processing is achieved by making the names on the labels visually distinct and novel, and large, bold and clear (use of size change, contrast) and by making it relevant to nurses (highlighting and isolating important information).

The Design Proposal (cont.)

In addition to using size to make the name visually distinct, look-alike/sound-alike name pairs are differentiated by contrasting parts of the name, as suggested by the FDA, with the *Name Differentiation Project*. Based on filter and bottleneck theories of attention proposed by Broadbent, Triesman and Deutsch and Deutsch, competition exists between different stimuli that affects which information is paid attention. Though each model suggests a different stage where filtering could occur before processing for meaning, the distinctiveness of the features are important in capturing attention. PDP models of cognition and parallel character recognition suggest that the feature level of characters are just as essential to word recognition as are the character, word and semantic levels. In Baddley's model of working memory, confusion is explained by the phonological similarity effect (the impaired recall of similar items that occurs because items that have similar phonological codes are more difficult to distinguish). The novel use of contrast within the name provides a change in the features of characters and can act as a cue for nurses, bringing problem names to their attention.

While the FDA's recommendations are a step towards avoiding name confusions and error, typographic research suggests that there are contrasts related to the attributes of a typeface, other than change of case, that could more effectively help to differentiate names. If we recognize words based on features, characters, and words as suggested by the parallel character recognition model, then it follows that using uppercase characters does not provide sufficient distinctiveness of features because the forms are not as varied or as legible as lowercase characters. This prototype will include the recommended change between lowercase and uppercase characters to differentiate names, as a point of departure and comparison.

Keeping in mind, Spencer's study that suggested a contrast of weight, rather than a contrast in type style or typeface as being more distinctive, a series of sketches were developed to visualize contrasts in: typestyle, typeface, case, weight and stance. Also, diagraphic elements were explored to give emphasis to key parts of the names; mark cues (rules and outlined shapes) provided a subtle contrast and solid shapes provided a stronger contrast and a shifting of the figure/ground relationship within the names from black to white type. (See Appendices 2 and 3)

Three variations that were selected were based on the desire to simplify the choice for participants and at the same time have enough variation that would test a range of degrees of contrast. These consisted of:

- the least extreme, contrast in case, a change from lowercase characters to uppercase characters;
- a middle ground, contrast in weight, a change from medium weight characters to bold face (lower case) characters; and
- the most extreme, contrast—a change from black characters to white characters on a solid black rectangle.

Figure 40
Three typographic
variations were developed
to highlight the differences
between pairs of look-
alike/sound-alike names.

HydrOXYzine	HydrALAzine
Hydro oxy zine	Hydr al azine
Hydr oxy zine	Hydr al azine

The Design Proposal (cont.)

The changes in case, weight, and colour, plus the addition of a rectangle, were compared to explore to what degree each of the contrasts help to differentiate the names. Names were tested in list formats in tests 2.1–2.2 by using recognition tasks and were also compared in the context of a label in Test 4, where participants were asked which pairs they perceived to be easier to read and why.

MAKING INFORMATION RELEVANT

According to Kahneman's resource theory, each task performed demands a given amount of attention. Maintaining attention during the course of an important task, such as, the administration of medications, was the goal. As noted by Pettersen, capturing and maintaining attention for further processing is fostered by highlighting and isolating relevant information.

The use of a relatively large type size in the drug name highlights the key information, as well as making it visually distinct in the context of the label because

- 1) viewers are not used to seeing a variety of type sizes on labeling from hospital pharmacies, therefore the novelty will capture their attention and
- 2) substantially larger text demands the immediate attention of the viewer.

In arranging the elements, USP label and packaging concerns with regards to the lack of prominent placement of drug name and strength were addressed. For this label design, the drug name and descriptive information that is deemed important to recognition is referred to as the "nameplate". It contains the drug name and other information that is immediately important for drug identification and the task of drug administration. Prominent positioning at the top of the label establishes its importance. Approximately 40% of the space on the label is devoted to this key information.

Figure 41
The drug name and descriptive information that is deemed important to recognition is referred to as the "nameplate."

Pleasantville Community Hospital 2219-12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401	Hydralazine Apresoline® 50 mg Tablets Antihypertensive	
	DIN 00005541	1 tablet orally at 8:00 with a full glass of water.
	Expiry: 1.15.05	
	RX#: 31262	Dr. P. Sanders
	Jones, Thomas	Room 37 Bed 2

Physical Level of Design – Helping users find information

In addition to attracting the attention of the viewer, unity and equilibrium as created by the harmonious arrangement of elements in a composition, helps viewers navigate through the visual field and provide crucial information required for decision-making. This is achieved by the careful balance of the figure/ground relationships, the organization of typographic elements and use of white space and the delicate balance of concord and contrast as discussed by Kohn, Carter, et al., Dair and McCreight.

The Design Proposal (cont.)

Legibility of text is crucial to ease of navigation through the label and is achieved through the careful consideration of formal typographic elements such as, (choice of typeface size, weight, etc.) and the arrangement of those elements.

LEGIBILITY: TYPEFACE SELECTION

Legibility is the most important consideration in selecting a family of type for use in drug names and labels. Based on the opinions of Carter, Day, Meggs, and studies by Paterson and Tinker, De Lange, et al. and an examination of various sans serif and serif typefaces, sans serif typefaces were deemed to be more appropriate because of their clarity and simplicity of design. Based on these qualities, Univers, Gill Sans, Futura, Rotis, Avenir, Meta and Frutiger were considered. (See Appendix 4)

Frutiger was selected because it possesses all of the aforementioned formal attributes that make it a highly legible typeface. It is a humanist sans serif characterized by a slight modulation in stroke weight and classical Roman structure. It exhibits well defined, simple character shapes, a generous x-height, large, open counters and is proportionally spaced, rather than monospaced. Because the Frutiger family contains a number of weights, it is especially useful in creating hierarchies and allows for visual adjustments (replacing with heavier or lighter weight to maintain the same appearance with very small type or very large type). The light medium and bold weights are used to create various levels of emphasis. A regular width versus the condensed or expanded versions was selected, as the latter two are not as legible due to the exaggerated counters, as noted by Rüegg and Carter, Day, Meggs. A mix of upper and lowercase characters, rather than all uppercase was applied, based on observations by Spencer and Tinker and Paterson that ease in reading declines with all uppercase possibly due to more fixation pauses (uppercase takes up more space), the lack of distinctive features exhibited by uppercase and familiarity in reading lowercase texts. As noted by Craig, italics should be used for “quiet emphasis.” Therefore, they were deemed inappropriate for these prototypes because they do not provide enough contrast to the Roman versions.

Figure 42
Because the Frutiger family of typefaces contains a number of weight variations, it is especially useful in creating hierarchies.

Hydroxyzine
Hydroxyzine
Hydroxyzine

ESTABLISHING A HIERARCHY: TYPE SIZES AND WEIGHT

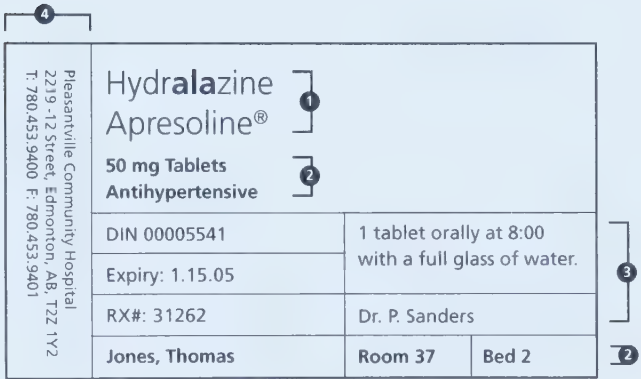
According to Carter, Meggs and Day, a visual hierarchy expresses the relative importance of elements in a composition/layout. In establishing the hierarchy, careful consideration was given to items on the label (such as the look-alike/sound-alike drug names) that require the heightened attention of a nurse. The hierarchy of text elements or components helps the reader navigate through a composition, signaling where one should enter and exit and is achieved through the use of visual cues, as noted by Lupton. On the prototype, the cueing of text occurs with a considerable difference in type size that

The Design Proposal
(cont.)

can help to capture the attention of the nurse and establish the name as the most important information on the label. To facilitate movement down the various levels of information, the type size is decreased, substantially. A change of weight is used to provide a subtle, but marked difference in the importance of text.

There are four levels of information on the label, with level one as the most important and level four as the least important in the hierarchy. The selection of type sizes used for the labeling was guided by Poulton's study of small types sizes; the minimum x-height measure recommended is 1.2 mm, which translates to 6.5 point in Univers Medium. The x-height of Frutiger 55 Roman (medium weight) is very close to that of Univers (and is in fact, slightly larger) and therefore, can be used for similar situations where space is limited. This size was used for level four text, the name and address information of the hospital. The next size up is 8 point text set in Frutiger 55 Roman (medium weight) used for level three, support information: the drug information number, expiry date, prescription number, instructions for administration of medications and physician's name. Level two information differs from level three, only in weight and is made up of information that is deemed to be important in helping identifying the name and the patient to whom the drug belongs: the dosage, form, therapeutic class and patient name, room number and bed number. To give this information slightly more emphasis it is set in a slightly heavier weight, Frutiger 65 Bold. The first and highest level, is the drug name. In order that attention is immediately focused on the drug name, it is set substantially larger than all other text (and larger than that normally used on medication labeling), in 14 point Frutiger 45 Light.

Figure 43
The hierarchy of text elements establishes the relative importance of information and helps the reader navigate through a composition. The levels are as follows: level 1, generic/brand names; level 2, information important in matching the drug to the patient; level 3, support information, useful for crosschecking and level 4, pharmacy contact information.



ORGANIZATION OF ELEMENTS

USP label and packaging concerns with regards to layout and poorly designed or cluttered labels were addressed by providing a unified, simple and uncomplicated layout based on the *gestalt* laws of perception. Proximity of elements helped to group items intended to be read as a unit. By placing the drug names, therapeutic class, dosage and form together, the user would be encouraged to read this information as a unit rather than as separate and unrelated items. Similarity in form that is created by using one family of type provides a sense of unity between typographic elements. Information is further separated by chunking the text and the use of spatial and mark cues (adding space between items and enclosing items within rules that make up horizontal shapes). This is in accordance with the *gestalt* law of closure, that suggests enclosed spaces are self-sustaining and stable in their organization.

The Design Proposal (cont.)

At the same time, based on the law of continuity, the rules also help to create a unified whole, an area, divided by rules, rather than a series of separate shapes.

An underlying structure was used to organize information in accordance with Josef Müller-Brockman's statement that information will not only be read more quickly and easily but will also be better understood and retained in the memory if the elements are placed on a grid. Locating information on the label is facilitated by the arrangement and predictable placement of the text in terms of alignment and the relationships that are created between the elements. Based on observations by Carter et al. and Craig, all text is set flush left/ragged right to take advantage of the optimal word and character spacing that it provides as well as the predictability of a common beginning point for each line (important for ease of reading). As noted by Carter, Day, Meggs the flush left/ragged right alignment allows each item to be broken for meaning and is placed on a separate line, providing a dedicated position on the label that would remain consistent on all labeling.

Figure 44

Three prototypes were developed: in the first, items had no additional space between them; in the second example, items had space between them, and in the third example, rules added further separated items, to make more of a distinction between items, to help make them easier to locate.

Pleasantville Community Hospital 2219 -12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401	Hydralazine Apresoline®	
	50 mg Tablets	
	Antihypertensive	
	DIN: 00005541	
	Expiry: 1.5.05	
	RX#: 31262	
	1 tablet orally at 8:00 with a full glass of water.	
	Dr. P. Sanders	
	Jones, Thomas — Room 37, Bed 2	

Pleasantville Community Hospital 2219 -12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401	Hydralazine Apresoline®	
	50 mg Tablets	
	Antihypertensive	
	DIN 00005541	1 tablet orally at 8:00
	Expiry: 1.5.05	with a full glass of water.
	RX#: 31262	Dr. P. Sanders
	Jones, Thomas	Room 37, Bed 2

Pleasantville Community Hospital 2219 -12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401	Hydralazine Apresoline®		
	50 mg Tablets		
	Antihypertensive		
	DIN 00005541	1 tablet orally at 8:00	
	Expiry: 1.15.05	with a full glass of water.	
	RX#: 31262	Dr. P. Sanders	
	Jones, Thomas	Room 37	Bed 2

The Design Proposal (cont.)

Cognitive Level of Design – Helping users understand information

Content appearing on the label was selected based on information required for the medication process that is active in short-term or accessed from LTM. The tasks include retrieving medications delivered by pharmacy, crosschecking drugs with patient charts, prescriptions, identification bracelets and labels and the administration of those medications to specific patients.

CONTENT REQUIRED FOR RELABELING

LTM as described by Lefrançois, though highly stable, is generative rather than reproductive and can be prone to error. Therefore, it is important to minimize the amount of information, to avoid clutter but at the same time, provide enough relevant information for ease in identification. In providing additional content information, nurses might be compelled to confirm that what they see on labeling is indeed for the intended patient. Nurses are trained to check for the 'five rights' of administration of drugs (the right drug, patient, dosage, time, route of administration). This represents the minimum amount of information that is required for proper administration. Readability issues (level of language) are addressed by the inclusion of information that nurses should be familiar with and trained to look for.

Of the legally required text legislated by the Pharmaceutical Profession Act (patient name, physician name, pharmacy name, address, telephone, pharmacists name, date dispensed, prescription number, generic/common name, dosage form, dosage strength, instructions for use) all were used, with the exception of the pharmacists name (not commonly used in hospital pharmacies, or if at all, as initials) and the dispensing date (given that these are 12 day cards, the date of dispensing is unnecessary and was replaced by the expiry date).

ADDITIONAL CONTENT: RICHNESS IN ENCODING

Accessing knowledge stored in LTM, could also be involved in the process of administering medications. Craik and Lockhart's levels of processing framework indicates that information that is meaningful and richly encoded is more easily retained and available for retrieval when required. This is dependant upon the level of processing that occurs when information is encoded. Orthographic encoding is at the shallowest level, phonological encoding is at a deeper level and semantic information is encoded at the deepest level.

Information is made memorable based up the elaboration, organization and distinctiveness to which it is encoded. Information is elaborated by associating it to previous knowledge. By linking descriptive information about the drug to information familiar to the nurse, there is a better chance of recall. In the case of unfamiliar drugs there is a better chance that it will be successfully encoded for future recall. The same follows for organization of information. By linking it to its therapeutic use and other characteristics such as its form and typical strength, drug information can be made memorable.

The Design Proposal (cont.)

1 Pleasantville Community Hospital 2219 -12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401	2 Hydralazine Apresoline® 50 mg Tablets Antihypertensive		
	3 DIN 00005541	7 1 tablet orally at 8:00 with a full glass of water.	
	4 Expiry: 1.15.05		
	5 RX#: 31262	8 Dr. P. Sanders	
	6 Jones, Thomas	9 Room 37	10 Bed 2

Figure 45
Labeling was developed to contain a limited number of meaningful chunks, to compensate for limitations in memory, therefore, line breaks occur, item by item.

1 Hospital Information <ul style="list-style-type: none"> • Hospital Name, • Address, • Telephone • Fax 	2 Nameplate <ul style="list-style-type: none"> • Generic Name • Brand Name • Dosage Strength, Form • Therapeutic Category
---	---

3 Drug Information Number DIN 00005541	7 Instructions <ul style="list-style-type: none"> • Quantity • Route of Administration • Time of Administration • Special Considerations 1 tablet orally at 8:00 with a full glass of water.
4 Expiry Date Expiry: 1.15.05	8 Prescribing Physician Dr. P. Sanders
5 Prescription Number RX#: 31262	9 10 Patient Location Room 37 Bed 2
6 Patient Name Jones, Thomas	

The Design Proposal (cont.)

Of the additional information, suggested by the Alberta College of Pharmacists the generic and brand name, dosage form and dosage strength, therapeutic category, expiry date and DIN, were included on labeling to promote richness in organization of drug information. The inclusion of brand name and the therapeutic category, as suggested by the FDA and JCAHO is useful for clarification and in determining the purpose of the medication for nurses who are familiar with their patients and their illnesses, but not necessarily familiar with the drug. The presence of the drug form provides information that may help identification by acting as a crosscheck. In addition, the DIN, unique to each drug, can be helpful when crosschecking against the information that appears on an electronic chart and/or drug database. The expiry date takes the place of dispensing date because of the nature of the 12 day card system.

VISUAL CUEING: FACILITATING COGNITION

Throughout the medication process, the nurse is confronted with the limitations of memory. Both STM, as illustrated by Atkinson and Shiffrin in their model with distinct memory stores and the alternative working memory model, developed by Baddley, where information from sensory data and from LTM is kept active is described as having a limited capacity and are prone to fade and disappear quickly. Because of this, the main portion of the labeling was developed to contain a limited number of meaningful chunks (9 in total, excluding pharmacy contact information, which is not important to identification of the drug), in keeping with Miller's theory that 7 items, plus or minus 2 can be kept active in memory. This is confirmed by Smith and Frase and Schwartz, who say we are more likely to recall and retain material that is set up to support meaningful units. As a result, with the descriptive drug information, line breaks occur item by item (with the exception of the instructions). According to Gilreath, the cueing of text to facilitate meaning can be verbal, visual or a combination of both. Typographic cues, such as, separating elements with subtle differences in weight, a substantial change in size, separating by chunking the text are used to help nurses process information. In addition, spatial and mark cues (rules) were applied to further separate information (adding space and rules between items).

DIFFERENTIATING NAMES: AVOIDING CONFUSION

In Baddley's model, memory traces that have similar phonological codes can cause confusion. Contrasting parts of the name that can help to differentiate (changes in case, weight, and colour, to white, plus the addition of a black rectangle) and making the entire name larger than other text on the label, as described previously, would help the nurse to distinguish between look-alike/sound-alike names and facilitate understanding in order to take the correct course of action.

Testing and Evaluation

Testing Methods

As previously mentioned, this exploratory study made use of a mixed method approach for testing, using both quantitative and qualitative data collection. Quantitative information was used to examine trends by comparing variations (visual design and the content included for names and labels, with look-alike/sound-alike drugs), while qualitative information was used to compare attitudes and opinions on the same material. Quantitative testing methods were used to measure the performance of the design and content elements. These tests consisted of word identification tasks with look-alike/sound-alike name pairs, shown in lists as well as within a label context. Qualitative tests measured the perceived ease in name recognition, the perceived ease of information search, professional opinions about issues surrounding confusion with drug names and demographic information.

Recognition and Recall: Measuring Memory

To understand how memory works and how information is encoded and retrieved, we can test how efficiently participants in a study can retrieve information from memory. The two types of information retrieval tasks that allow us to measure memory are recognition and recall. With recall tasks, after shown a stimulus list, the participant must produce a fact, word or other item from memory without the help of a prompt list. With recognition tasks, the participant must identify information from a prompt list that contains some information from the previously viewed stimulus list.

Retention depends on:

- retention interval – the more time between exposure and recognition/recall, the less retained
- list length – the longer the list, the less retained
- serial position – in free recall, the first (primacy effect) and last items (recency effect) are more likely to be recalled than the items in the middle
- depth of processing – retention for semantically processed items is better than retention for the physical features
- study time – generally, retention is greater when more time given to the material
- encoding specificity – retention is better when the environment for learning and testing are similar
- distinctiveness of cues – retention increases when the stimulus is distinctive
- testing method – it is easier to recognize an item, rather than recall it (Haberlandt, 239)

Closed and Open-ended Questions: Interpreting Opinions

The use of closed and open-ended questions allows for interpretation of the attitude, opinions and demographics of participants. Closed-ended questions require participants to answer from a set of answers (for example: yes/no or strongly agree, somewhat agree, somewhat disagree, strongly disagree). It gives the participants a choice, helping them respond to a question that they may have difficulty answering. Questions are easy to score and summarize for establishing trends. Open-ended questions allow participants to use their own words and to answer questions that are not constrained and predetermined by the researcher. These questions allow for a richness and diversity in response but are more difficult to categorize, sort and summarize. (Beins, 206-208)

Testing and Evaluation (cont.)

Application of Testing Methods

Questionnaire:

Eliciting Demographic Information and Opinions

This questionnaire was designed to elicit demographic information and opinions in order to better understand the motivation of nurses, working in acute care hospitals and their perception of problems associated with look-alike/sound-alike drug names.

Testing Method:

Participants were asked a closed-ended and open-ended questions. (See Appendix 5)

Measures:

The responses to closed-ended questions were measured quantitatively to establish trends. Qualitative text analysis was used for open-ended questions to help develop themes based on their opinions of issues surrounding look-alike/sound-alike drug names and medication errors.

Tests 1.1, 1.2 – Word Recognition Tasks:

Testing Look-alike/sound-alike Drug Names for Content

These tests were designed to explore whether nurses recognize look-alike/sound-alike drug names when the names were made up of the following:

- one word-names (either the generic or brand name)
- two-word names (both the generic and brand names)

The use of both generic and brand names on labeling has been suggested by the FDA and JCAHO to help reduce errors. These tests were designed with consideration to the limitations/strengths of the user in terms of cognitive processing. Retention of information in recognition and recall tasks depends upon: retention interval, list length, serial position, depth of processing, study time, encoding specificity, distinctiveness of cues and testing method.

Testing Method:

Participants were shown a list of drug names. This list was taken away and second list was shown and they were asked to indicate which words they recognized from the first list. Recognizing items is easier than recall, therefore, they were cued with a second list, rather than recalling words, from memory. The structure of this test makes this a recognition task, as opposed to a recall task, and simulates what might transpire in a hospital setting where confirmation and double checking of drugs with patient charts, other written and verbal instructions, prescriptions and packaging occurs. (See Appendix 6)

Retention Interval:

Participants were shown a second list after 15 seconds of exposure. In this test, there was no rest time between exposure and recognition, so that recognition would not suffer from a lapse in time.

Testing and Evaluation (cont.)

List Length:

Each test displayed seven names in order that participant's STM would not be taxed (based on Miller's theory that humans have a capacity to retain seven items, plus or minus two, in short-term/working memory).

Serial Position:

The position of items was changed from the stimulus list to the list used for recognition, therefore, primacy and recency effects were avoided.

Depth of Processing:

As put forward by Craik and Lockhart, in the Levels of Processing model of memory, material that has been richly encoded and stored in LTM, is easier to retrieve. Therefore, these tests were set up to explore the possibility that additional information (using both the generic and brand names) could help trigger knowledge stored in LTM. In the case of unfamiliar names, the addition of a second name could act as a cue for recognition.

Study Time:

Study time of 15 seconds simulated the limited time a nurse may have in matching medications from pharmacy to patients and allowed for 2 or 3 readings of the seven names.

Encoding Specificity:

The environment of the testing did not match the environment in which the actual task might occur.

Measures:

Quantitative measures were used to compare the performance of one word versus two-word names.

Tests 2.1, 2.2, 2.3 – Word Recognition Tasks:

Testing Look-alike/sound-alike Drug Names for Formal Attributes (Typography)

These tests were designed to explore how easily drugs with look-alike/sound-alike names could be distinguished when the appearance of the part of the name, which differed from its corresponding look-alike name, was changed. In the context of labels, names are made distinct by the use of:

- 1) uppercase characters to differentiate parts of the name
- 2) bold characters to differentiate parts of the name
- 3) white characters on a black rectangle to differentiate parts of the name

These tests were designed based on the observations of USP that there is a lack of differentiation between products that have similar names. The *FDA's Name Differentiation Project* suggested that a change in part of the look-alike/sound-alike names could bring the problem names to the attention of healthcare workers.

These tests were designed with consideration to the limitations/strengths of the user in terms of cognitive processing, regarding attention. Retention of information in recognition and recall tasks depends upon: retention interval, list length, serial position, depth of processing, study time, encoding specificity, distinctiveness of cues and testing method.

Testing and Evaluation (cont.)

Testing Method:

Participants were shown a list of drug names. This list was taken away and second list was shown and they were asked to indicate which words they recognized from the first list. Recognizing items is easier than recall, therefore, they were cued with a second list, rather than recalling words, from memory. The structure of this test makes this a recognition task, as opposed to a recall task, and simulates what might transpire in a hospital setting where confirmation and double checking of drugs with patient charts, other written and verbal instructions, prescriptions and packaging occurs. (See Appendix 7)

Retention Interval:

Participants were shown a second list after 15 seconds of exposure. In this test, there was no rest time between exposure and recognition, so that recognition did not suffer from a lapse in time.

List Length:

Each test displayed seven names so that participant's STM were not taxed (based on Miller's theory that humans have a capacity to retain seven items, plus or minus two, in short-term/working memory)

Serial Position:

The position of items was changed from the stimulus list to the list used for recognition, therefore, primacy and recency effects were avoided.

Depth of Processing:

Because this test focused on visual differentiation and issues of attention and short-term/working memory, the names in this test might be memorized based on their physical features (according Craik and Lockhart's model, at a shallow level of encoding).

Study Time:

Study time of 15 seconds simulated the limited time a nurse may have in matching medications from pharmacy to patients and allowed for 2 or 3 readings of the seven names.

Encoding Specificity:

The environment of the testing did not match the environment in which the actual task might occur.

Distinctiveness of Cues:

As suggested by Rune Pettersen, the use of visual devices can influence the viewer in order to engage and maintain their attention. By making the names visually distinct and novel (using contrast on parts of the names that differentiates the name), issues of attention are addressed. In order to get an indication of how much contrast is necessary, a range of three variations were tested and compared, from the least to the greatest contrast.

Measures:

Quantitative measures were used to compare the performance of the three levels of differentiation.

Testing and Evaluation (cont.)

Tests 3.1 – 3.7 – Content Identification Tasks: Testing Drug Labels for Content

These tests were designed to help explore the presence of information on drug labels that might help nurses identify drug label and were based upon strategies recommended by the FDA and JCHAO. According to their recommendations, the purpose of the medication (described by the therapeutic class) and the inclusion of both the generic and brand names of the drug could help to reduce risk in hospitals. Dosage form is required text, legislated by the Pharmaceutical Profession Act (Alberta). On the prototypes, the drug form was placed in a prominent position in order to test its effectiveness in helping to identify the position of the drug label on the page. This test was also intended to establish whether this type of content was relevant to the nurses when looking at drug labels.

These tests were designed with consideration to the limitations/strengths of the user in terms of cognitive processing, regarding attention, perception and understanding. The cognitive level of design addresses the user's ability to understand and make use of information. Retention of information in recognition and recall tasks depends upon: retention interval, list length, serial position, depth of processing, study time, encoding specificity, distinctiveness of cues and testing method.

Testing Method:

Participants were shown a pair of drug labels. When the pair was taken away, they were asked to identify the positioning of the labels by either therapeutic class, drug form or generic name. Because they were cued with a word that appeared on the label, it is considered a recognition task and simulates what might transpire in a hospital setting where a brief exposure to labeling might occur. (See Appendix 8)

Retention Interval:

Participants were asked to identify whether the label appeared on the left or right side after 15 seconds of exposure. In this test, there was no rest time between exposure and identification, so identification did not suffer from a lapse in time.

List Length:

Each label displayed nine items, so that participant's STM would not be taxed (based on Miller's theory that humans have a capacity to retain seven items, plus or minus two, in short-term/working memory).

Depth of Processing:

As put forward by Craik and Lockhart, in the Levels of Processing model of memory, material that has been richly encoded and stored in LTM, is easier to retrieve. Therefore, these tests are set up to explore the possibility that additional information (using both the generic and brand names, therapeutic use, form, etc.) may help trigger knowledge stored in LTM. In the case of unfamiliar names, the addition of a second name might act as a cue for recognition.

Study Time:

Study time of 15 seconds simulated the limited time a nurse may have in matching medications from pharmacy to patients and allows for 2 or 3 readings of the two labels.

Encoding Specificity:

The environment of the testing did not match the environment in which the actual task might occur.

Testing and Evaluation (cont.)

Test 5 – Question and Opinion: Testing Drug Labels for Formal Attributes (Layout)

In Test 5, participants were asked to give opinions regarding the ease with which they could find information on pairs of labels when information was:

- 1) not chunked (with no cueing)
- 2) grouped/chunked (with spatial cues)
- 3) grouped/chunked with rules separating items (with spatial and mark cues (rules))

This test was designed to elicit opinions based on perception and understanding. As observed by Gilreath, studies of the effects of typographic and spatial cueing show that this method of organizing a layout can facilitate comprehension of text for various types of reading strategies: careful serial reading, searching, surveying, browsing, and skimming. In order to get an indication of what nurses perceive to be necessary for ease in finding information, three levels of cueing were tested and compared (no cueing, spatial cueing and mark cueing).

Testing Method:

Participants were asked a closed-ended question and an open-ended question about the three pairs of prototypes. They were asked in which of three pairs was it easiest to find information and to explain why. (See Appendix 10)

Measures:

Responses concerned with the perceived ease in which information could be found on the three pairs of prototypes was measured quantitatively. Qualitative text analysis helped to establish trends and develop themes based on their opinions of the effectiveness of three levels of cueing.

Testing the Prototypes

The participant pool consisted of a total of 11 acute care nurses from two community hospital. There were 7 nurses in the first group and 4 nurses in the second group. Results include the combined numbers from both groups, therefore, n=11 in all of the tests.

Questionnaire

Research Questions:

What is the nursing designation and the number of years of experience of each nurse?

What level of awareness do nurses have regarding the problem of look-alike-sound-alike name confusions?

Do nurses know of measures that are be taken to avoid errors with look-alike/sound-alike drug names?

Do nurses think that a visual system may help to reduce incidence of error with look-alike/sound-alike drug names?

Testing and Evaluation (cont.)

Distinctiveness of Cues:

As suggested by Rune Pettersen, the use of visual devices can influence the viewer in order to engage and maintain their attention. By making the layout visually distinct and novel (using visual cueing, such as mark cues (rules) and spatial cues and using contrast on parts of the names that differentiates the name), issues of attention were addressed. In order to get an indication of how much contrast is necessary, a range of three variations were tested and compared, from the least to the greatest contrast.

Measures:

Quantitative measures were used to compare the performance of the three levels of differentiation.

Test 4 – Question and Opinion:

Testing Look-alike/sound-alike Drug Names on Labels for Formal Attributes (Typography)

This test was designed to gather opinions/judgments on how easily drugs with look-alike/sound-alike names could be distinguished when the appearance of the part of the name, which differs from its corresponding look-alike name, was changed. In the context of labels, names are made distinct by the use of:

- 1) uppercase characters to differentiate parts of the name
- 2) bold characters to differentiate parts of the name
- 3) white characters on a black rectangle to differentiate parts of the name

The label prototype was designed based on the recommendation of The *FDA's Name Differentiation Project* suggested that a change in part of the look-alike/sound-alike names could bring the problem names to the attention of healthcare workers.

This test was intended to elicit opinions about capturing attention by the differentiation of look-alike/sound-alike names. As suggested by Pettersen, the use of visual devices can influence the viewer in order to engage and maintain their attention. By making the names visually distinct and novel (using contrast on parts of the names that differentiates the name), issues of attention were addressed. In order to get an indication of how much contrast the nurses perceive to be necessary for differentiation, a range of three variations were tested and compared, from the least to the greatest contrast.

Testing Method:

Participants were asked a closed-ended question and an open ended question about the three pairs of prototypes. They were asked in which of three pairs was the drug most easily distinguished and to explain why. (See Appendix 9)

Measures:

The responses to which of the three pairs of prototypes showed the best differentiation of names, as perceived by nurses, was measured quantitatively. Qualitative text analysis helped to establish trends and develop themes based on their opinions of the effectiveness of three levels of differentiation.

Testing and Evaluation (cont.)

Method:

Participants

Eleven acute care nurses from two community hospitals participated in this study.

Procedure

Participants had up to 20 minutes to complete a questionnaire that contained six questions. The first three questions related to their nursing designation and experience. The fourth question asked about the present measures taken to avoid errors with look-alike/sound-alike names. The final two questions asked their opinions on medication error due to look-alike/sound-alike names and the effectiveness of a visual system to help differentiate look-alike/sound-alike names.

Measures

Trends based on the similarity in responses to the questions and comments, were documented and analyzed.

Location:

These tests took place in one of two locations—a hospital meeting room or an office.

Materials:

The materials used for this test were a pen and a one-page document that contained questions and included space for participants to record their observations. (See Appendix 5)

RESULTS AND DISCUSSION

The results of the questionnaire were helpful in providing information about the nurses, their awareness about confusion with drug names, their level of concern and whether or not they thought a visual system might help with name differentiation.

Question 1

What is your nursing designation? (For example: registered nurse, nurse practitioner, licensed practical nurse, registered psychiatric nurse)

A total of eleven nurses from two hospitals participated in this study. 73% (8/11) nurses were Registered Nurses (RN) and 27% (3/11) were student nurses. This indicates that there were two types of nurses participating in the study, the majority of which were experienced and had their registered nursing designation and those less experienced and working toward their designation, as might be the case on a typical acute care nursing unit.

Question 2

How many years of experience do you have working in health care?

The average number of years experience for the whole group was 16.6, while the average number of years in nursing for the RNs was 21.9 years and 2.9 years, for the student nurses. Because of the mixture of registered nurses and student nurses, the group that participated could be considered representative of the average number of years of experience in an acute care nursing unit.

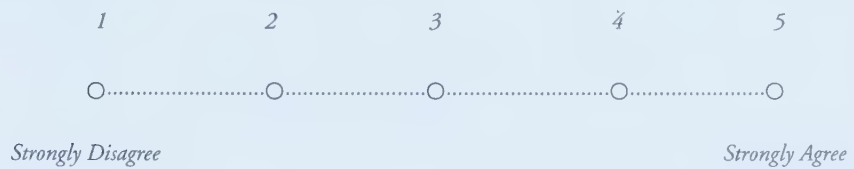
- This shows that attempts to alert nurses to look-alike/sound-alike are working in terms of capturing attention, indicating that if there was some type of distinction made between names, it might be acknowledged. This might result in the proper course of action by holding attention long enough to properly process information and/or to double-check information when unsure about a drug.

**Testing
and Evaluation
(cont.)**

Question 5:

To what extent do you agree or disagree with the following statement?

A visual system that would somehow flag or highlight look-alike/sound-alike drug names could help to differentiate the names.



100% rated their agreement as 4 or higher.

The results of this Test show that nurses agree that a visual system could help eliminate drug name confusions, indicating that, from the nurses' perspective, information design has the potential to affect a positive change to the problem of medication error due to look-alike/sound-alike names

Figure 46

Questionnaire Results

Question 1	RN	Student Nurse	n=11
	8	3	

Question 2	Number of Years	Number of Years
	20	3
	30	2
	5	3
	35	
	25	
	16	
	14	
	30	

Question 3	1	2	3	4	5
	1	0	0	4	6

Question 5	1	2	3	4	5
	0	0	0	2	9

Testing and Evaluation (cont.)

Testing Look-alike/sound-alike Drug Names for Content:

Test 1.1 Generic or Brand Name

Test 1.2 Generic Name and Brand Name

Question:

Is it easier to recognize look-alike/sound-alike drug names when the names are made up of:

- one name (either the brand or generic name) or
- two names (both the generic and brand names)?

Expected outcomes:

It was expected that participants would be more likely to identify drug names correctly when both the generic and brand names were used together.

Method:

Participants

Eleven acute care nurses from two community hospitals participated in this study.

Procedure

In Test 1.1, participants were shown a list of seven drugs in the form of a pair of generic or brand names that have been identified as look-alike/sound-alike pair. They had 15 seconds to examine the names. The first list was taken away and a second list was shown that included some of the names from the first list and some new names. Participants were given up to 30 seconds to identify which of the names were common to the first list.

In test 1.2, participants were shown a list of seven drugs that consisted of a pair of names – both the generic and brand names – that have been identified as look-alike/sound-alike pair. They had 15 seconds to examine the names. The first list was taken away and a second list was shown that included some of the names from the first list and some new names. Participants were given up to 30 seconds to identify which of the names were common to the first list.

Measures:

The number of names correctly identified were counted out of seven, in test 1.1 and again in Test 1.2 and were compared to see whether the change from one-word names to two-word names affected the number of names that were successfully identified.

Location:

These tests took place in one of two locations—a hospital meeting room or an office.

Materials:

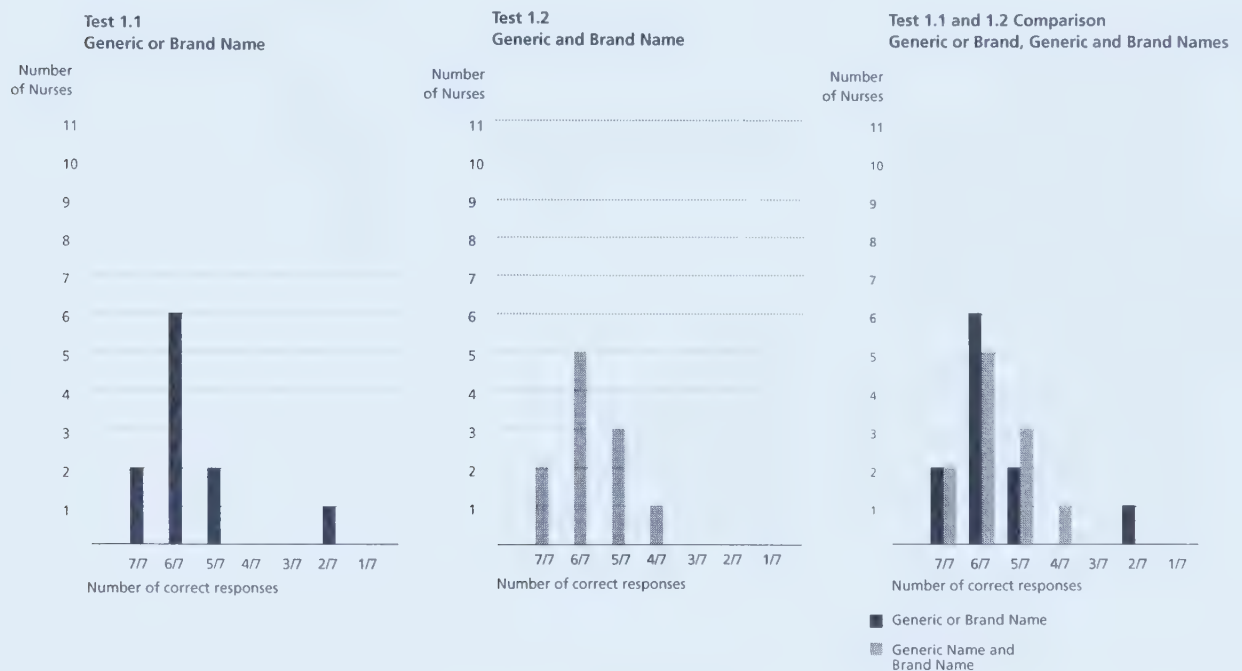
Materials used for this Test were a pen, two stimulus lists and corresponding second lists for participants to indicate their responses. (See Appendix 6)

Testing and Evaluation (cont.)

RESULTS AND DISCUSSION

In both Tests 1.1 (generic or brand name) and 1.2 (generic and brand name), 91% (10/11) of the participants were able to identify five or more out of seven names. In both Tests 1.1 and 1.2, 18% (2/11) of participants were able to correctly identify all seven names on the list. In Test 1.1, 55% (6/11) participants correctly identified six out of seven names versus 45% (5/11) of participants in Test 1.2. Contrary to the expected outcome of these tests, the results indicate that there was not an appreciable difference when participants were presented with Test 1.1, only the generic or brand name and Test 1.2, the generic and brand name, suggesting that there may not be an advantage to having both names present on labeling. Based on the small sample size, assumptions cannot be made for either case, with certainty.

Figures 47-49
Test 1.1, 1.2 Results and Comparison



Testing Look-alike/sound-alike Drug Names for Formal Attributes (Typography):

Test 2.1 Use of Uppercase Characters to Differentiate Parts of Drug Names

Test 2.2 Use of Bold Face Characters to Differentiate Parts of Drug Names

Test 2.3 Use of White Characters on a Black Rectangle to Differentiate Parts of Drug Names

Research Question:

Is it easier to recognize look-alike/sound-alike drug names by changing part of the name that makes it distinct by using:

- uppercase characters to differentiate parts of drug names or
- bold face characters to differentiate parts of drug names or
- white characters on a black rectangle to differentiate parts of drug names.

Testing and Evaluation (cont.)

Expected Outcomes:

It was expected that participants would be more likely to correctly identify drug names that use white characters on a black rectangle, to differentiate parts of the name, than those that use bold face characters or uppercase characters. This version was expected to be more effective because it provides the greatest contrast. Also, it was expected that the version with bold face lowercase characters would be easier to identify than the version with uppercase characters, because of the higher contrast in stroke weight.

Method:

Participants

Eleven acute care nurses from two community hospitals participated in this study.

Procedure

In Test 2.1, participants were shown a list of seven drugs comprised of one of a pair of generic or names that have been identified as look-alike/sound-alike pair. In this list, uppercase characters were used to differentiate parts of the name that differed from its corresponding look-alike name. Participants had 15 seconds to examine the names. The stimulus list was taken away and a second list was shown that included some of the names from the first list and some new names. Participants had up to 30 seconds to identify which of the names were common to the stimulus list. Names on the second list were typeset in a single typeface (characters were not differentiated in any way). Participants had up to 30 seconds to identify which of the names were common to the stimulus list.

In Test 2.2, participants were shown a list of seven drugs comprised of one of a pair of generic or brand names known to be a look-alike/sound-alike name. In this list, bold face characters were used to differentiate parts of the name that differ from the corresponding look-alike name. Participants had 15 seconds to examine the names. The stimulus list was taken away and a second list was shown that included some of the names from the first list and some new names. Participants had up to 30 seconds to identify which of the names were common to the stimulus list. The names on the second list were typeset in a single typeface (characters were not differentiated in any way). Participants had up to 30 seconds to identify which of the names were common to the stimulus list.

In Test 2.3, participants were shown a list of seven drugs comprised of one of a pair of generic or brand names that is known to be a look-alike/sound-alike name. In this list, white characters on a black rectangle were used to differentiate parts of the name that differed from its corresponding look-alike name. Participants had 15 seconds to examine the names. The stimulus list was taken away and a second list was shown that included some of the names from the first list and some new names. Participants had up to 30 seconds to identify which of the names were common to the stimulus list. The names on the second list were typeset in a single typeface (characters were not differentiated in any way). Participants had up to 30 seconds to identify which of the names were common to the stimulus list.

Measures:

The number of names that were correctly identified were counted out of seven in Test 2.1, Test 2.2 and Test 2.3 and were compared to see if, and where, the change in appearance of the names affected the number of names that were successfully identified.

Testing and Evaluation (cont.)

Location:

These tests took place in one of two locations—a hospital meeting room or an office.

Materials:

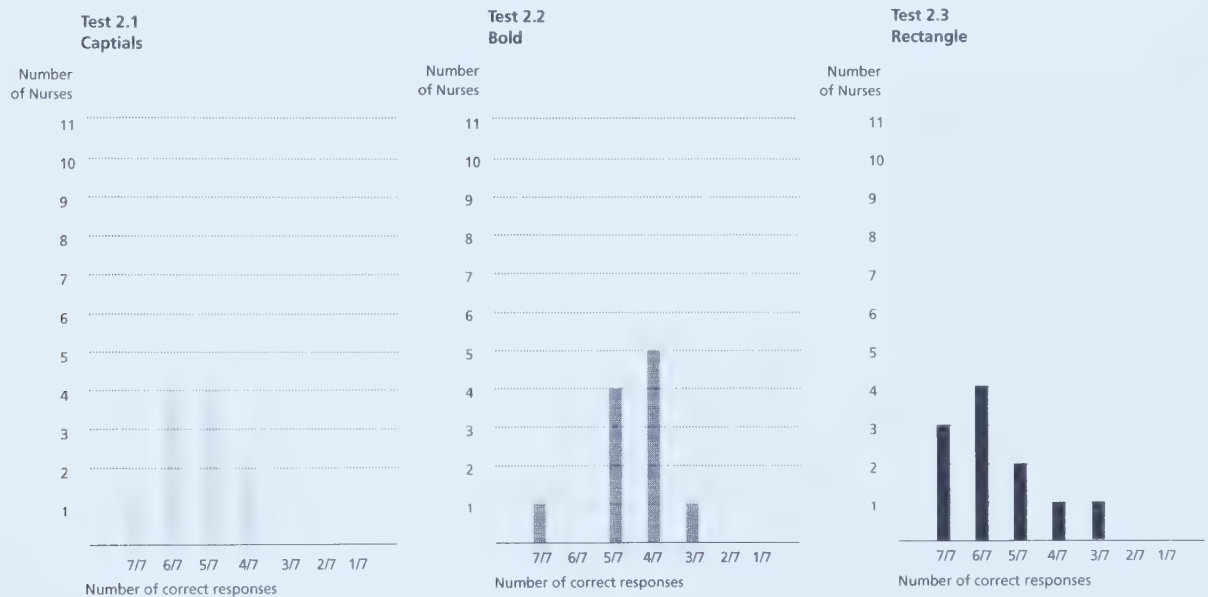
Materials used for these Test were a pen, three stimulus lists and corresponding second lists for participants to indicate their responses. (See Appendix 7)

RESULTS AND DISCUSSION

In both Tests 2.1, where uppercase characters were used to differentiate parts of drug names and Test 2.3, where white characters on a black rectangle were used to differentiate parts of drug names, 81% (9/11) participants recognized five or more names, out of seven. Only 45% (5/11) participants recognized five or more names in 2.2, where bold face characters were used to differentiate parts of drug names, suggesting that both 2.1, uppercase version and 2.3, the white characters on the black rectangle, were more effective in helping to distinguish names. Test 2.3, 27% of participants recognized all seven names compared to 9% (1/11) in both 2.1 and 2.2.

Figures 50-52

Test 2.1, 2.2, 2.3 Results



Testing and Evaluation (cont.)

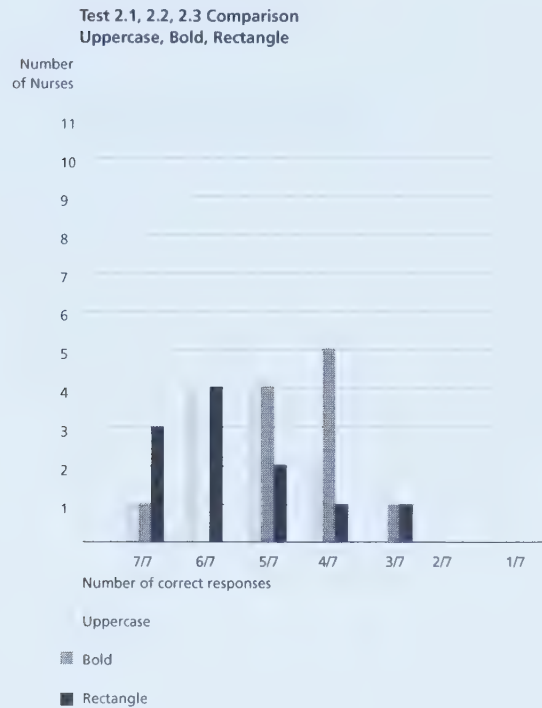


Figure 53
Test 2.1, 2.2, 2.3
Comparison of Results

These results partially coincide with the expected outcomes. The expectation was that both the bold face and the white type on a black rectangle would perform better than the use of uppercase characters. The results indicate that the bold face text did not help to differentiate as much as using uppercase characters, while white characters on a black rectangle to differentiate parts of drug names resulted in the highest number of participants who were able to identify all seven names.

Testing Drug Labels for Content:

Test 3.1 Therapeutic Category with full text

Test 3.2 Drug Form with Therapeutic Category Absent

Test 3.3 Therapeutic Category with Therapeutic Category Absent

Test 3.4 Drug Form with Therapeutic Category and Form Absent

Test 3.5 Therapeutic Category with Brand Name Absent

Test 3.6 Generic Name with full text

Test 3.7 Generic Name with brand name absent

Research Questions:

Does the therapeutic class help in the identification of drug labeling?

Does the placement of the drug form in a prominent position help in the identification of drug labeling?

Does the absence of the brand name hinder the identification of drug labeling?

Do the presence of both the generic and brand names help in the identification of drug labeling?

Testing and Evaluation (cont.)

EXPECTED OUTCOMES

Test 3.1 Content Identification: Therapeutic Category with full text

Test 3.3 Content Identification: Therapeutic Category with Therapeutic Category Absent

Test 3.5 Content Identification: Therapeutic Category with Brand Name Absent

It was expected that participants would successfully choose the correct label position when asked to identify the therapeutic category more often in 3.1, the full text version.

Test 3.2 Content Identification: Drug Form with Therapeutic Category Absent

Test 3.4 Content Identification: Drug Form with Therapeutic Category and Form Absent (from name plate but included in instructions)

It was expected that participants would be more likely to successfully choose the correct label position when asked to identify by the drug form more often in 3.2, with only the therapeutic category absent but form present.

Test 3.6 Content Identification: Generic Name with full text

Test 3.7 Content Identification: Generic Name with brand name absent

It was expected that participants would be more likely to successfully choose the correct label position when asked to identify by generic name more often in 3.7 when the generic name was combined with the brand name.

- 1) It was expected that participants would be more likely to successfully identify the correct position of labels when asked by generic name or brand name, rather than drug form or therapeutic use.
- 2) It was expected that participants would be more likely to successfully identify the correct position with labels that were identified by generic name combined with the brand name.
- 3) It was expected that participants would be more likely to successfully identify the correct position of labels when they were provided more information, rather than less information.

Method:

Participants

Eleven acute care nurses from two community hospitals participated in this study.

Procedure

Participants were shown a set of two labels. Each contained the name of one of two look-alike/sound-alike drugs, (e.g. hydroxyzine and hydralazine), the indications, the form, dosage, instructions, physician's name, patients name, drug identification number, date, prescription number and contact information for the pharmacy.

In Test 3.1, participants were asked to read the text on the labels for 15 seconds. The labels were taken away and they were asked to identify where, on the page (left or right side), the *antidepressant* drug label was positioned. (therapeutic class)

In Test 3.2, participants were asked to read the text on the labels for 15 seconds. The labels were taken away and they were asked to identify where, on the page (left or right side), the label of the drug in *capsule form* was positioned. (drug form)

Testing and Evaluation (cont.)

In Test 3.3, participants were asked to read the text on the labels for 15 seconds. The labels were taken away and they were asked to identify where, on the page (left or right side), the *anitepileptic* drug label was positioned. (therapeutic class)

In Test 3.4, participants were asked to read the text on the labels for 15 seconds. The labels were taken away and they were asked to identify where, on the page (left or right side), the label of the drug in *capsule form* was positioned. (drug form)

In Test 3.5, participants were asked to read the text on the labels for 15 seconds. The labels were taken away and they were asked to identify where, on the page (left or right side), the *diuretic* drug label was positioned. (therapeutic class)

In Test 3.6, participants were asked to read the text on the labels for 15 seconds. The labels were taken away and they were asked to identify where, on the page (left or right side), the *Bupirone HCl* label was positioned. (generic name)

In Test 3.7, participants were asked to read the text on the labels for 15 seconds. The labels were taken away and they were asked to identify where, on the page (left or right side), the *Hydroxyzine* label was positioned. (generic name)

Measures:

In each test, the total number of label positions correctly identified by participants were counted and compared to see how the presence or absence of content would affect the identification of label's position on the page.

Location:

These tests took place in one of two locations—a hospital meeting room or an office.

Materials:

The materials used for this Test were a pen, 7 two-page documents. The first page, showed a pair of prototypes and the second page included a question and space for a response. (See Appendix 8)

Figure 54
Tests 3.1 – 3.7 Results

Responses	Correct	Incorrect	n=11
Test 3.1	9	2	
Test 3.2	5	6	
Test 3.3	5	6	
Test 3.4	4	7	
Test 3.5	10	1	
Test 3.6	9	2	
Test 3.7	10	1	

Testing and Evaluation (cont.)

Tests 3.1, 3.3, 3.5

In Test 3.1, where labels that contained all information (generic and brand names and therapeutic class), participants were asked to identify the label based on therapeutic class (an antidepressant), 81% (9/11) answered correctly. In Test 3.3, where labels contained all information (except therapeutic class), participants were asked to identify the label, based on therapeutic class (an antiepileptic), only 45% (5/11) answered correctly. In Test 3.5, where labels contained all information except the brand name, participants were, again, asked to identify the label, based on therapeutic class (a diuretic), 91% (10/11) answered correctly.

Based on the results of Tests 3.1 (presence of generic and brand name) compared to 3.5 (presence of only generic name) it seems that there is not an appreciable difference in the identification of the label when asked to identify by therapeutic class. This result is consistent with the results in Tests 1.1 and 1.2, where there was not a great difference in the recognition of words based on exposure to generic or brand names versus generic and brand names.

In the case of Test 3.3, the absence of the therapeutic class seems to have affected identification negatively, with only 45% (5/11) participants answering correctly. In comparison, 81% (9/11) of the participants in Test 3.1 and 91% (10/11) in Test 3.5 (where the therapeutic class was present) correctly answered the question. Correct identification could have occurred in Test 3.1 and 3.5 because after a brief exposure, information was active in working memory. Also, it is possible that the drug was familiar to nurses. The results Test 3.3 could be due to lack of familiarity with the drug and therefore, absence of the therapeutic class produced incorrect responses. If the drug is not part of the formulary of the hospital in which the nurses are employed, they might not be familiar with it.

The results in Test 3.1, with the presence of both generic and brand names and in Test 3.5, with the absence of brand name, were not substantial enough to conclude that their presence or absence make a difference in label identification when asked to identify based upon therapeutic class. However, it is possible that the presence of therapeutic class could help in identification of a drug because these two tests show that nurses paid attention to it. Whether or not the drug is familiar to nurses, the therapeutic class could act as a cue for the nurse to verify that drug would have the correct the therapeutic action, compatible with the patient's illness.

Tests 3.2, 3.4

In Test 3.2, where all the information was present on the label, except the therapeutic class, participants were asked to identify the label for the drug that was in capsule form. (Note: The form of the drug appears on the nameplate and in the instructions for use.) Only 45% (5/11) participants correctly identified the label. In Test 3.4, where the label did not include the drug form on the nameplate, but did contain the form in the instructions for use, the results were slightly lower with 36% (4/11) of participants answering correctly. These results indicate that perhaps when looking at drug labeling, the drug form is not as important as other information. As was the case in Tests 3.1, 3.3 and 3.5 this may be due to unfamiliarity with the drug. Results for this test were contrary to the expected outcome, that the presence of the drug form would help in identification of the label when asked to identify by drug form. This indicates that nurses do not pay much attention to drug form when looking at drug labeling and therefore suggests that the presence of drug form on labeling may not be crucial to the identification of drugs.

Testing and Evaluation (cont.)

Tests 3.6, 3.7

In Test 3.6, where all the information was present on the label, 81% (9/11) of participants answered correctly when asked to identify the label for the drug *Buspirone HCl* (the drug's generic name). In Test 3.7, where all information was present on the label, except for the brand name, 91% (10/11) answered correctly when asked to identify the label for the drug *Hydroxyzine* (the drug's generic name). Though the results for identification of the label with both the generic and brand names were slightly lower (10%), it was not substantial enough to conclude with certainty that identification is more likely with the only the generic name. It is, however, interesting to note the similar results in Test 3.1 with the presence of both generic and brand names compared to Test 3.5 with the absence of brand name, identification by therapeutic class was 9% lower with the presence of both generic and brand names.

Testing Look-alike/sound-alike Drug Names on Labels for Formal Attributes (Typography):

Test 4 Typographic Attributes and Differentiation

Research Question:

How easily can drugs with look-alike/sound-alike names be distinguished when the appearance of the part of the name, which differs from its corresponding look-alike name, was changed with:

- 1) uppercase characters to differentiate parts of the name or
- 2) bold characters to differentiate parts of the name or
- 3) white characters on a black rectangle to differentiate parts of the name?

Expected outcome:

The expected outcome of this test was that participants would perceive that names differentiated with the highest level of differentiation, white characters on a black rectangle, would be easiest to distinguish than those with uppercase characters. In addition, it was expected that the boldface characters would be perceived to be more easily identified than the version with uppercase differentiating the names.

Method:

Participants

Eleven acute care nurses from two community hospitals participated in this study.

Procedure

The testing was in the form of questions related to a set of visuals, used in order to elicit opinions as to the relative ease of distinguishing the drug names on three pairs of labels. Participants were shown three pairs of labels. Each contained the name, of one of two look-alike/sound-alike drugs, (*hydroxyzine* and *hydralazine*), the indications, the form, dosage, instructions (route of administration, time and quantity of drug) physician's name, patients name, drug identification number, expiry date, prescription number and address/telephone/fax numbers of the hospital pharmacy. The pairs were presented in three different ways: 1) uppercase used to differentiate parts of the name, 2) bold characters used to differentiate parts of the name and 3) white characters on a black rectangle used to differentiate parts of the name. Participants were asked in which of three pairs was the drug name most easily distinguished and to explain why.

Testing and Evaluation (cont.)

Measures:

The number of selections for each of the three pairs of labels (with names differentiated by uppercase characters, bold face characters or white characters placed on a black rectangle) was quantified and compared to each other. Trends based on the similarity in comments were documented and analyzed. These were also compared with the results of the identification tests 2.1 – 2.3.

Location:

These tests took place in one of two locations—a hospital meeting room or an office.

Materials:

The materials used for this test were a pen and a one-page document which showed three pairs of prototypes and included space for participants to record their observations. (See Appendix 9)

RESULTS AND DISCUSSION

Figure 55
Test 4 Results

Preference for:	1) Uppercase	2) Bold	3) Rectangle	None	n=11
	2	4	4	1	

In Test 4, participants were asked their to give their opinion regarding the ease in differentiating between drug names when:

- 1) uppercase characters were used to differentiate parts of drug names
 - 2) where bold face characters were used to differentiate parts of drug names
 - 3) white characters on a black rectangle were used to differentiate parts of drug names
- 36% (4/11) chose bold face characters, 36% (4/11) chose the white characters on a black rectangle and 18% (2/11) chose uppercase characters while 9% (1/11) participants thought that none of the choices made the names easy to differentiate. These results are consistent with the expected outcomes, that either 2) boldface or 3) white characters on a black rectangle would be selected as easiest to read.

Participants who chose the version with uppercase characters expressed that this version gave enough, but not too much differentiation and said:

“[Uppercase are] a subtle enough reminder and enough to alert you. [With the others, there is] too much focus [and I] tend not to look at [the] beginning and [the] end[ing] of word[s,] which could cause error as well.”

Testing
and Evaluation
(cont.)

“[The version with uppercase characters] seem cleaner—more concise—mak[ing] you actually look at the whole word instead of focusing on [the] bold or squared part.”

When asked to explain why they chose bold face, participants were consistent in their views, claiming it seemed to be the right amount of differentiation:

“...[boldface] is distinctive enough to alert for possible mistakes.”

“It still seems like its part of the name, yet it highlights the [characters] that makes it different from other drugs...”

“...[the boldface] is simpler to look at and does not detract too much from the rest of the drug name.”

“...with the syllable just [bold] I see the whole word.”

They commented on why they didn't choose the versions with uppercase or white characters on a black rectangle, with most of them finding these design variations too conspicuous.

“When the syllable is in uppercase letters or blocked I find this distracting, that's all I see.”

“...on the other [two, the] first thing I notice is the uppercase [characters] and the bolded/blocked [characters].”

In one case, the participant chose 2 and mentioned 3, explained:

“... #2 is slightly better than #3 because the bold lettering is simpler to look at and does not detract from the remainder of the lettering in the drug name. #3 — the black square is effective but detracting too much from the rest of the drug name.”

Testing and Evaluation (cont.)

The participant who chose none of three thought that:

“Only having certain [characters] bold or uppercase takes longer to look at the drug and could cause confusion.”

The same participant suggested having all of the characters bold, rather than differentiating only some of the characters.

The comments made on this test indicate that most participants perceived that differentiating the name with uppercase characters does not make the names distinctive enough. This suggests that more contrast may be required, as in versions 2 and 3. Participants who chose versions 2 and 3 were split evenly. Given that this is small study, it is difficult to generalize with the results. Perhaps a larger sample size would provide a stronger result for one over the other.

It is interesting to compare these results of Tests 4, a qualitative test, to those in tests 2.1 – 2.3, a quantitative test, where participants recognized names with a higher level of accuracy when the method of differentiation was white characters on a black rectangle and the next most accurate was uppercase characters and last, boldface characters. Testing the variations by recognition as in Tests 2.1 – 2.3, may be a more accurate of evaluating the methods of differentiation. In addition, if they are within a label context, the results may truly reflect what would occur in a nursing unit. The results of this test coincide with the expected outcome; drug names differentiated with boldface characters or white characters on a black rectangle, are perceived to be easier to distinguish than those with uppercase characters.

Testing Drug Labels for Formal Attributes (Layout) :

Test 5 Layout Variations and Finding Information

Research Question:

What type of layout is perceived to be the most helpful in trying to find information on drug labeling if information is:

- 1) not chunked (with no cueing) or
- 2) grouped/chunked (with spatial cues) or
- 3) grouped/chunked with rules separating items (with spatial and mark cues (rules))?

Expected Outcome:

The expected outcome of this test was that drug labels that had information grouped/chunked with rules separating them would be perceived to be easier to find.

Testing
and Evaluation
(cont.)

Method:

Participants

Eleven acute care nurses from two community hospitals participated in this study.

Procedure

A qualitative testing method, in the form of questions related to a set of visuals, was used in order to elicit opinions as to the relative effectiveness of three pairs of labels. These choices and the explanations for the choices were quantified and compared.

Participants were shown three pairs of labels. Each set contained the name, of one of two look-alike/sound-alike drugs, (*hydroxyzine* and *hydralazine*), the indications, the form, dosage, instructions (route of administration, time and quantity of drug) physician's name, patients name, drug identification number, expiry date, prescription number and address/telephone/fax numbers of the hospital pharmacy. The labels varied in their layout and three levels of cueing. Participants were asked to give their opinions regarding the ease with which they could find information in each of the sets when information was:

- 1) not chunked (with no cueing)
- 2) grouped/chunked (with spatial cues)
- 3) grouped/chunked with rules separating items (with spatial and mark cues (rules))

Measures:

The number of selections, for each of the three pairs of labels, that used various levels of cueing, was quantified and compared. Trends based on the similarity in comments were documented and analyzed.

Location:

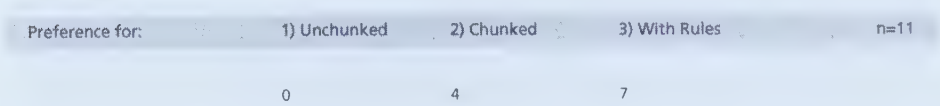
These tests took place in one of two locations—a hospital meeting room or an office.

Materials:

The materials used for this test were a pen and a one-page document which showed three pairs of prototypes and included space for participants to record their observations. (See Appendix 10)

RESULTS AND DISCUSSION

Figure 56
Test 5 Results



Testing and Evaluation (cont.)

In Test 5, participants were asked to give opinions regarding the ease with which they could find information in pairs of labels when information was:

- 1) not chunked (with no cueing)
- 2) grouped/chunked (with spatial cues)
- 3) grouped/chunked with rules separating items (with mark cues (rules))

The labels containing grouped/chunked information were selected by 36% (4/11) participants and 64% (7/11) participants chose the labels containing grouped/chunked information with rules. These results are consistent with the expected outcomes – that information that is grouped/chunked, with rules separating items, would be easiest to read.

Participants who chose the chunked version thought that the space between items was helpful in finding information.

“The space between info helps group the relevant info whereas when it all runs together, I don’t ‘see’ any of it...”

“The space below the type of drug makes it stand out more.”

“...[The chunked version] is separated enough.”

They also said that extra space was sufficient for separation of information and commented that the lines in version three interfered in locating information.

“...spacing provides a “break” for the reader without distracting lines or boxes...”

“[the version with rules separating items is] too choppy with boxes...”

Those who chose the version with rules separating items found that they could target very specific information with ease.

“The boxes separate the info into individual compartments making it easier to pick out specific information.”

“# 3 is clearly delineated. [My eyes] go straight to info without having to search.”

Testing and Evaluation

“It’s very clear and distinctive; I would be able to direct my eyes to which box of information needed at the moment.”

“Having it broken down into categories helps you see where the expiry date is quick you don’t need to read through the whole thing and when in a hurry you need accessibility.”

“All information is separated and makes it easy to locate exactly what you need to know.”

“By having the info separated on the chart is easier to follow than the others because there is more space between the information.”

“It’s easy to understand because everything has its own spot and its separated to make each block stand out.”

The comments made on this test indicate that ease of locating information, very quickly is very important in the process of assigning the right medication to the patient. The importance of the visual cues (information grouped and separated with rules) was noted by the participants, suggesting that spatial and mark cues (rules) are perceived as being helpful in the search for specific information. The mark cues were seen as more helpful than spatial cues. Information that had no cueing was not selected by any of the participants. As expected, the outcome of this test was that drug labels that had information grouped/chunked with rules separating them would be perceived to be easier to find.

Design Recommendations

Accepting that errors will occur, the prototypes in this exploratory study were designed to help minimize the incidence of error in administering due to confusion with look-alike/sound-alike drugs names by taking into consideration the affective, physical and cognitive strengths and/or limitations of acute care nurses. This involves issues surrounding the nurse's motivation and attention, perception, and understanding.

Following, are recommendations based upon the findings in this exploratory study.

Affective Level of Design – Helping users perform

Issues concerned with bringing about motivation can be addressed by:

Acknowledging and acting upon the problem of look-alike/sound-alike medication errors by providing a visual system for labeling.

Issues of capturing and maintaining attention can be addressed by:

Engaging the nurses and calling his/her attention to look-alike/sound-alike names by accentuating the differences of look-alike/sound-alike drug names on labeling.

Based on filter and bottleneck theories of attention proposed by Broadbent, Triesman and Deutsch and Deutsch, competition exists between different stimuli, so the distinctiveness of the features are important in capturing attention. In agreement are PDP models of cognition and parallel character recognition which suggest that the feature level of characters are just as essential to word recognition as are the character, word and semantic levels. According to Pettersen, attention can be captured and maintained by using various visual strategies such as distinctiveness, novelty, contrast, making elements large, bold and clear. He also believes, in accordance with Kahneman's resource theory, that highlighting and isolating relevant information is important to attention. In Baddley's model of working memory, confusion is explained by the phonological similarity effect (the impaired recall of similar items that occurs because items that have similar phonological codes are more difficult to distinguish). A solution to these problems is the FDA's *Name Differentiation Project* (that helps to distinguish look-alike/sound-alike name pairs by contrasting parts of the name). Based on these models and theories, the findings in the word recognition tasks, and the qualitative tests where nurses said that it was easiest to distinguish names when differentiation was made with white type on a black rectangle, it is recommended that:

- Elements on the label should be made visually distinct by using contrast to differentiate look-alike/sound-alike names. This can be achieved by changing part of the name from black type to white on a black rectangle in an area that helps to distinguish the name.
- Emphasizing relevant items by highlighting (names should be larger than all other text), isolating (placing names prominently at the top of the label with ample space around them) and having key information occupy a substantial amount of the label space (at least 40%).

Design Recommendations (cont.)

Physical Level of Design – Helping users find information

Issues concerned with facilitating perception can be addressed by:

Guiding nurses through the various levels of information by structuring the text, providing visual cues and information flags for maximum legibility.

This is achieved by the careful balance of the figure/ground relationship; the organization of typographic elements and use of white space and the delicate balance of concord and contrast as discussed by Kohn, Carter, et al., Dair and McCreight. The design of the label should provide a unified, simple and uncomplicated layout based on the *gestalt* laws of perception: proximity, similarity, continuity, closure and figure/ground relationships.

- Information, key to drug identification should be grouped in close proximity to form a “nameplate.” Remaining text should be grouped where possible, (instructions should contain the dose, route of administration, the time of administration and special considerations.)
- Visual cueing, the chunking of text and the use of extra space (spatial cues) and rules between items (mark cues) should be used to divide information into stable units and at the same time help to maintain unity within the composition.
- One family of type containing a variety of typefaces, should be selected because the similarity in form will provide a sense of unity within the composition.

An underlying structure was used to organize information in accordance with Josef Müller-Brockman’s statement that information will not only be read more quickly and easily but will also be better understood and retained in the memory if the elements are placed on a grid. Locating information on the label is facilitated by the arrangement and predictable placement of the text in terms of alignment and the relationships that are created between the elements. It is recommended that:

- Information be arranged on a grid to create a unified and uncluttered labeling. This will establish relationships between elements as well as predictable placement, important for ease in navigation.

According to Carter et al. and Craig, text set flush left/ragged right has the advantage of optimal word and character spacing and the predictability of a common beginning point for each line. Therefore, it is recommended that:

- Each item should be placed on a separate line and aligned flush left/ragged right.

Legibility of text is crucial to ease of navigation through the label and is achieved through the careful consideration of formal typographic elements such as, (choice of typeface size, weight, etc.) and the arrangement of those elements. Legibility is the most important consideration in selecting a family of type for use in drug names and labels. Based on the opinions of Carter, Day and Meggs, Rüeegg, Craig and studies by Spencer, Paterson and Tinker, Poulton, De Lange, et al. the following should be considered:

- Clear, legible sans serif typefaces, such as Frutiger family, set in a mix of upper and lowercase characters, should be used to promote legibility.

Design Recommendations (cont.)

- In selecting the weights, character width and stance, the versions that are less severe in their visual characteristics, for example a regular weight as opposed to extra bold, should be considered. Using a variety of character weights (light, medium, bold), a regular character width, and the Roman version will ensure that the characteristics are not exaggerated and will help, rather than hinder legibility.

According to Carter, Meggs and Day, a visual hierarchy should be used in a composition/layout to express the relative importance of elements. In order to help the reader navigate through a composition, signaling where one should enter and exit and is achieved through the use of visual cues, as noted by Lupton. Therefore, a hierarchy should be established, with the following suggestions:

- Visual cues such as the use of a larger size for drug name, set at 14 point, will indicate its importance in relation to secondary drug and patient specific information, set at 8 point.
- The least important text, pharmacy contact information, should be set at a minimum of 6.5 point.
- Within the secondary information an additional level of change should occur with the subtle use of the boldface text (Frutiger 65 Bold).
- All other text should be set in Frutiger 55 Roman (medium weight), except for the drug name, that requires a visual adjustment to the lighter weight, because of the increase in size.

Cognitive Level of Design – Helping users understand information

Issues concerned with facilitating understanding can be addressed by:

Informing nurses and providing relevant information by incorporating text that can help identify the medication for maximum readability.

It is important to minimize the amount of information, to avoid clutter but at the same time, provide enough relevant information for ease in identification. There is a minimum amount of information that is legally required text legislated by the Pharmaceutical Profession Act that must be included. Nurses are trained to check for the 'five rights' of administration of drugs (the right drug, patient, dosage, time, route of administration). This represents the minimum amount of information that is required for proper administration. Readability issues (level of language) are addressed by the inclusion of information that nurses should be familiar with and trained to look for. Therefore, the following is required:

- Items that are required to satisfy legal requirements on hospital pharmacy relabeling and content commonly used by nurses for double-checking medications should be integrated into labeling.

According to Craik and Lockhart's levels of processing framework which indicates that information that is meaningful and richly encoded in LTM is more easily retained and available for retrieval when required. Additional information suggested by the Alberta College of Pharmacists, the FDA and JCAHO, is deemed as useful for identification and clarification. This was demonstrated with the label identification tasks, when nurses were able to identify labels, based on information other than

Design Recommendations (cont.)

drug name. In cases where additional information did not seem to affect identification, it can still be considered useful for confirming or cross-referencing. Based on this information, the following is recommended:

- Therapeutic class should be included on labeling to promote richness in encoding.
- Items that may be included for confirmation purposes are, both generic and brand names, drug information number.

Given the limited capacity of STM, Miller's theory that 7 items, plus or minus 2 can be kept active in memory, provided they are divided into meaningful chunks. This is confirmed by Smith and Frase and Schwartz, who say we are more likely to recall and retain material that is set up to support meaningful units. According to Gilreath, the cueing of text to facilitate meaning can be verbal, visual or a combination of both. According to the qualitative tests and questions regarding composition/layout, nurses preferred information that was chunked and contained spatial and mark (rules) cues to separate items. Based on this, the following is recommended:

- Visual cues, such as chunking information, typographic, spatial cues and graphic cues (rules) should be applied to separate information in order to help nurses process information.
- Information should be chunked up to a maximum of nine items into meaningful units (with line breaks occurring at the end of each item, with the exception of instructions).
- Changes in size and weight and space and rules between items help to distinguish items and help process information for meaning.

Limitations

- 1) The sample size for this exploratory study was eleven, making it impossible to come to definitive conclusions based on the results.
- 2) The settings for the study, an office, does not reflect the atmosphere of the acute care hospital ward, where there would be additional distractions and which might alter the results.
- 3) In the case of word identification task, participants had been primed (they were aware that the tests involved look-alike/sound-alike names) and may have been especially cautious about making distinctions between the names in the two lists.
- 4) In both the word identification tasks and the content identification tasks, the nurses participating in the tests may not have been familiar with the drugs selected for this study. In this case, recognition became purely a short-term memory exercise. This may not necessarily be seen as a drawback, rather, a function of what might actually occur in a hospital. Because changes may take place in a hospital pharmacy's formulary, (due to cost, availability or discontinued products) or new product releases, at some point in his/her career, a nurse might be confronted with unfamiliar drugs.

Conclusions

The interdisciplinary approach to this study provided the background for an in-depth analysis of the problem of errors due to look-alike/sound-alike errors in medicine and the factors involved in helping to reduce error, namely, drug information and naming, human factors psychology, cognitive psychology, psycholinguistics, perception, content issues, typography and composition/layout. This provided the background information that influenced the content and formal aspects of the design.

The results of this exploratory study indicate that aspects of information design, in terms of content and form (typography and composition/layout) could be applied to a labeling system intended to help minimize medication error caused by confusion of look-alike/sound-alike drug names. Because this was an exploratory study, it is difficult to make conclusive statements regarding the effectiveness of the label prototypes developed in this study. However, general observations can be made.

- There did not seem to be a marked advantage in the use of both the generic and brand names, over just the generic or just the brand. However, using both could help nurses to confirm or crosscheck that it is indeed the right drug for administration to the right patient.
- The use of a high contrast change within the look-alike/sound-alike drug names seemed to help differentiate names more often, than a change with lower contrast. This was case in both quantitative and qualitative testing.
- Additional information on labeling seems to help in the identification of labels. The testing suggests that some of the additional information is more relevant to nurses than other information. For example, the therapeutic class seems to be more salient than the drug form. Again, in circumstances where confirmation is required, this information may be important.
- Nurses are aware and concerned with the problem of errors due to look-alike/sound alike drugs.
- Nurses are aware of measures taken to avoid errors with look-alike/sound-alike.
- Nurses are of the opinion that a visual system could help to reduce the incidence of error due to look-alike/sound-alike drugs.

The last three statements indicate that a visual system would be noticed and valued by nurses in acute care hospitals as positive support against the hazard caused by look-alike/sound-alike drugs.

To conclude, though limited in sample size, the testing conducted with the end-users, nurses employed in an acute care hospital environment, provided positive feedback regarding the labeling design and an indication that the testing methods utilized in this exploratory study could be implemented, with success, on a larger scale.

A Look to the Future

This study was concerned with the problem of errors in medicine caused by confusion with look-alike/sound-alike drug names and how the application of information design could help to minimize their occurrence. The differentiation of names might be particularly helpful in applications across the healthcare system if applied consistently to all print and electronic materials used in the medication process that contain drug names (for example, paper and electronic forms of drug monographs and other drug information sources, prescriptions, packaging, labeling, syringes and I.V. bags). In order to promote a safety in the healthcare environment, every effort should be made to help minimize risk to patients. A positive step towards this end would be to develop, design, test/evaluate and implement materials that contain look-alike/sound-alike drug names so that nurses and other healthcare workers are supported in their efforts to provide the highest quality care that every individual deserves.

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Appendix

- 1 Drug Names and Their Uses
- 2 Name Differentiation – Typographic Variations
- 3 Name Differentiation – Diagraphic Variations
- 4 Typeface Variations
- 5 Questionnaire
- 6 Tests 1.1 - 1.2
- 7 Tests 2.1 -2.3
- 8 Tests 3.1 - 3.7
- 9 Test 4
- 10 Test 5
- 11 Thesis Exhibition

(Adapted from Berman, A. Boring, D., Government of Canada)

Type of Name	Developer or Regulator	User	Description
<ul style="list-style-type: none">Chemical Name	<ul style="list-style-type: none">International Union of Pure and AppliedChemistry (IUPAC)	<ul style="list-style-type: none">ChemistsRarely used clinically	<ul style="list-style-type: none">Identifies the molecular structure and configuration (lengthy and complicated)Chemical Abstracts Service (CAS) is an indexing and referencing system to the worldsChemical literature and is administered by The American Chemical SocietyCumbersome, and problems with intellectual property
<ul style="list-style-type: none">Official Non proprietary NameGeneric NameProper Name	<ul style="list-style-type: none">National, U.S.A: United States Adopted Name CouncilNational, Canada: Health CanadaCentre for Drug Evaluation and Research (CDER)	<ul style="list-style-type: none">Health Care Providers—Physician, Pharmacists, Nurses, Medical Technicians	<ul style="list-style-type: none">Public domain, so allows unrestricted communication between scientistsNames not trademarkedName stems incorporated to give some indication of chemical or therapeutic characteristicsName of a biologic as applied to a productName designated on license for use on package of a productName with reference to a drug in English or FrenchName of the dispensing form
<ul style="list-style-type: none">International Non proprietary Name (INN)			<ul style="list-style-type: none">Identify a drug substance by a unique, universally applicable and accepted generic name.Mixtures of substance cannot be assigned INNs (if they don not have a defined chemical composition or structure or that cannot adequately be described)
<ul style="list-style-type: none">Established NameCompendial Pharmacopial NameThe Official Title	<ul style="list-style-type: none">USP Nomenclature Committee	<ul style="list-style-type: none">Health Care Providers—Physician, Pharmacists, Nurses, Medical Technicians	<ul style="list-style-type: none">Established by appearing in the official pharmacopoeia of a country (USP in the U.S.A. and CPS in Canada)Titles for Compendia Monographs contain 1) official non-proprietary name of a drug substance, 2) route of administration, 3) dosage form (Established Name)For most, the official title is the same as the generic but it may include dosage, formulation and route of administrationUsed for all legal and regulatory matters pertaining to an individual substance and all official correspondence
<ul style="list-style-type: none">Proprietary NameBrand NameTrademark Name	<ul style="list-style-type: none">Pharmaceutical Manufacturers	<ul style="list-style-type: none">Health Care Providers—Physician, Pharmacists, Nurses, Medical TechniciansGeneral Public	<ul style="list-style-type: none">Developed in order to produce brand loyalty, recognitionCan be descriptive and sometimes implies effects of a drugOwned by an individual company and is part of their intellectual property portfolioPatents, copyright, licenses, trademark laws protect against improper useCan be registered with patent office, most do, but protected anyway by trademark law with reference to a drug, the name, whether or not including the name of any manufacturer or corporation partnership or individual in English and FrenchName under which a drug is sold or advertisedName that is used to distinguish a drug
<ul style="list-style-type: none">Trivial Name	<ul style="list-style-type: none">Pharmaceutical manufacturers, in the research and development process assign a code designation to a compound	<ul style="list-style-type: none">Researchers, Chemists	<ul style="list-style-type: none">Coined for convenience in research paper or on a hospital site during a drug study or mnemonic for computer databaseAlso, when company loses proprietary name to a public domain, ex. Aspirin and ASA for acetylsalicylic acidSometimes acronymsSometime hamper adoption of official nomenclature
<ul style="list-style-type: none">Code Designation	<ul style="list-style-type: none">Pharmaceutical manufacturers, in the research and development process assign a code designation to a compound	<ul style="list-style-type: none">Researchers, Chemists	<ul style="list-style-type: none">Acronyms, coined for convenience in research paper or on a hospital site during a drug study or mnemonic for computer database, ex. ASA for acetylsalicylic acid
<ul style="list-style-type: none">Pharmacy Equivalent Name (PEN)	<ul style="list-style-type: none">Some official Pharmacopoeias (including USP)	<ul style="list-style-type: none">PhysiciansPharmacists	<ul style="list-style-type: none">Proposed in cases where impractical to write official titleUsed for convenience only -- does not supersede complete titlePEN not an official nameNot required on labeling eg. co-trimoxazole - combines syllables from trimethoprim and sulfamethoxazole

Appendix 2

Name Differentiation – Typographic Variations

HydrOXYzine	Hydroxyzine
HydrALAZine	Hydr <i>al</i> azine

Hydr OXY zine	Hydroxyzine
Hydr ALA zine	Hydr <i>al</i> azine

HydrALAZine	Hydroxyzine
HydrOXYzine	Hydr <i>al</i> azine

HydrOXYzine	Hydr <i>oxy</i> zine
HydrALAZine	Hydr <i>al</i> azine

Hydr oxy zine	Hydr oxy zine
Hydr <i>al</i> azine	Hydr al azine

Hydr oxy zine
Hydr al azine

Hydr oxy zine
Hydr al azine

Appendix 3

Name Differentiation – Diagraphic Variations

Hydr**oxy**zine

Hydrooxyzine

Hydr**ala**zine

Hydralazine

Hydr**OXY**zine

Hydrooxyzine

Hydr**ALA**zine

Hydralazine

Hydr|oxy|zine

Hydr|oxy|zine

Hydr|ala|zine

Hydr|ala|zine

Hydroxyzine

Hydralazine

Appendix 4

Typeface Variations

Univers 55 Medium

Hydralazine

Univers 45 Light

Hydralazine

Futura Regular

Hydralazine

Futura Light

Hydralazine

Frutiger 55 Roman

Hydralazine

Frutiger 45 Light

Hydralazine

Avenir 55 Roman

Hydralazine

Avenir 45 Book

Hydralazine

Gill Sans

Hydralazine

Gill Sans Light

Hydralazine

Meta Bold

Hydralazine

Meta Normal

Hydralazine

Rotis Sans Serif Regular 55

Hydralazine

Rotis Sans Serif Light 45

Hydralazine

Letter Gothic Bold

Hydralazine

Letter Gothic Light

Hydralazine

Appendix 5

Questionnaire

1. What is your nursing designation? (For example: registered nurse, nurse practitioner, licensed practical nurse, registered psychiatric nurse)

2. How many years of experience do you have working in health care?

3. To what extent do you agree or disagree with the following statement?

The problem with look-alike/sound alike drug names as a cause of medication errors in health care is a serious problem.

1 2 3 4 5

☐ ☐ ☐ ☐ ☐

Strongly Disagree

Strongly Agree

4. What measures (if any) are you aware of that can be taken to avoid errors with look-alike/sound alike drug names? (for example: auxiliary labels, warnings, bulletins, special storage etc.)

5. To what extent do you agree or disagree with the following statement?

A visual system that would somehow flag or highlight look-alike/sound alike drug names could help to differentiate the names.

1 2 3 4 5

☐ ☐ ☐ ☐ ☐

Strongly Disagree

Strongly Agree

Appendix 6

Tests 1.1 – 1.2

Examine the following list of drug names:

Depo-Medrol

Losec

Prednisone

Morphine HCl

Novasen

Cerebyx

Micronor

Circle the names that you recognize from the previous list.

Prednisone

Monacor

Depo-Medrol

Norvasc

Celexa

Morphine HCl

Lasix

Examine the following pairs of drug names:

Dopamine HCl
Intropine

Bupropion HCl
Wellbutrin SR

Dimenhydrinate
Gravol

Zantac
Ranitidine HCl

Prednisone
Winpred

Ceftriaxone Sodium
Rocephin

Cyclophosphamide
Cytosan

Circle the pairs of names that you recognize from the previous list.

Cefotaxime Sodium
Claforan

Cyclophosphamide
Cytosan

Dopamine HCl
Intropine

Prednisolone
Pred Forte

Bupropion HCl
Wellbutrin SR

Zantac
Ranitidine HCl

Diphenhydramine HCl
Benadryl

Appendix 7

Tests 2.1 – 2.3

Examine the following list of drug names:

aMIODARone

moGADon

novo-spiroZINE

epiNEPHrine

solu-CORTEF

accuPRIL

ALPRAZolam

Circle the drug names that you recognize from the previous list.

epinephrine

novo-spiroton

clonazepam

solu-medrol

accupril

amiodarone

modulon

Examine the following list of drug names:

Lisinopril

Cisplatin

Andriol

Cefazolin Sodium

Hydroxyzine

Clomiphene

Pentobarbital

Circle the drug names that you recognize from the previous list.

Clomiphene

Lisinopril

Carboplatin

Phenobarbital

Andriol

Cefoxitin Sodium

Hydroxyzine

Examine the following list of drug names:

Vin**cris**tine

Lami**vud**ine

Atenolol

Diazepam

Taxo**tere**

Hum**alog**

Ser**oquel**

Circle the drug names that you recognize from the previous list.

Humalog

Atenolol

Diazepam

Sertraline HCl

Vinblastine

Lamotrigine

Taxotere

Appendix 8

Tests 3.1 – 3.7

Read the text on these labels.

<div>Pleasantville Community Hospital 2219-12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401</div>	<div>Bupropion HCl Wellbutrin SR® 100 mg Tablets Antidepressant</div>		
	DIN: 00005541	1 tablet orally at 8:00. Do not chew/crush/divide.	
	Expiry: 1.15.05		
	RX#: 31261	Dr. N. Airdrie	
	Peterson, Janice	Room 24	Bed 2

<div>Pleasantville Community Hospital 2219-12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401</div>	<div>Buspirone HCl BuSpar® 10 mg Tablets Anxiolytic</div>		
	DIN: 00646016	1 tablet orally at 14:00.	
	Expiry: 1.15.05		
	RX#: 31260	Dr. N. Airdrie	
	Peterson, Janice	Room 24	Bed 2

Was the antidepressant label on the:

- ☐ *Left Side?* ☐ *Right Side ?*

Read the text on these labels.

Hydroxazine Novo-Hydroxyzin® 50 mg Capsules		
DIN: 00646016	1 capsule orally at 8:00 with a full glass of water.	
Expiry: 1.15.05		
RX#: 31263	Dr. P. Sanders	
Jones, Thomas	Room 37	Bed 2

Pleasantville Community Hospital
 2219 - 12 Street, Edmonton, AB, T2Z 1Y2
 T: 780.453.9400 F: 780.453.9401

Hydralazine Apresoline® 50 mg Tablets		
DIN: 00005541	1 tablet orally at 8:00 with a full glass of water.	
Expiry: 1.15.05		
RX#: 31262	Dr. P. Sanders	
Jones, Thomas	Room 37	Bed 2

Pleasantville Community Hospital
 2219 - 12 Street, Edmonton, AB, T2Z 1Y2
 T: 780.453.9400 F: 780.453.9401

Read the text on these labels.

Pleasantville Community Hospital 2219 - 12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401	Lamivudine Heptovir® 100 mg Tablets		
	DIN: 00646016	1 tablet orally at 8:00 with or without food.	
	Expiry: 1.15.05		
	RX#: 31266	Dr. M. Smith	
	McDonald, Carrie	Room 36	Bed 1

Pleasantville Community Hospital 2219 - 12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401	Lamotrigine Lamictal® 100 mg Tablets		
	DIN: 00005541	2 tablets orally at 8:00 with a full glass of water.	
	Expiry: 1.15.05		
	RX#: 31267	Dr. M. Smith	
	McDonald, Carrie	Room 36	Bed 1

Was the antiepileptic label on the:

- ☐ *Left Side?* ☐ *Right Side ?*

Read the text on these labels.

Pleasantville Community Hospital 2219-12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401	Quetiapine Fumarate Seroquel® 100 mg		
	DIN: 00005541	1 tablet orally at 8:00.	
	Expiry: 1.15.05		
	RX#: 31265	Dr. C. Janzen	
	Francis, Teresa	Room 32	Bed 2

Pleasantville Community Hospital 2219-12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401	Sertraline HCl Zoloft® 100 mg		
	DIN: 00646016	1 capsule orally at 8:00 with food.	
	Expiry: 1.15.05		
	RX#: 31264	Dr. C. Janzen	
	Francis, Teresa	Room 32	Bed 2

Was the label of the drug in capsule form on the:

- ☐ *Left Side?* ☐ *Right Side ?*

Read the text on these labels.

Pleasantville Community Hospital 2219-12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401			
<div><div><div>Amlodipine</div><div>5 mg Tablets</div><div>Antihypertensive–Antianginal</div></div></div>			
DIN: 00878928		1 tablet orally at 12:00.	
Expiry: 1.15.05			
RX#: 31261		Dr. P. Renfrew	
Frazier, Joseph		Room 30	Bed 1

Pleasantville Community Hospital 2219-12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401	Amloride HCl		
	5 mg Tablets		
	Antikaliuretic–Diuretic		
	DIN: 00487805	2 tablets orally at 12:00.	
	Expiry: 1.15.05		
RX#: 31260	Dr. P. Renfrew		
Frazier, Joseph	Room 30	Bed 1	

Was the diuretic label on the:

- ☐ *Left Side?* ☐ *Right Side ?*

Read the text on these labels.

Pleasantville Community Hospital 2219 - 12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401	Bupropion HCl Wellbutrin SR® 100 mg Tablets Antidepressant		
	DIN: 00005541	1 tablet orally at 8:00. Do not chew/crush/divide.	
	Expiry: 1.15.05		
	RX#: 31261	Dr. N. Airdrie	
	Peterson, Janice	Room 24	Bed 2

Pleasantville Community Hospital 2219 - 12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401	Buspirone HCl BuSpar® 10 mg Tablets Anxiolytic		
	DIN: 00646016	1 tablet orally at 14:00.	
	Expiry: 1.15.05		
	RX#: 31260	Dr. N. Airdrie	
	Peterson, Janice	Room 24	Bed 2

Was the Buspirone HCl® label on the:

- ☐ *Left Side?* ☐ *Right Side ?*

Read the text on these labels.

Pleasantville Community Hospital 2219 -12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401	Hydrox ^{oxy} zine		
	50 mg Capsules Anxiolytic		
	DIN 00646016	1 capsule orally at 8:00 with a full glass of water.	
	Expiry: 1.15.05		
	RX#: 31263	Dr. P. Sanders	
	Jones, Thomas	Room 37	Bed 2

Pleasantville Community Hospital 2219 -12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401	Hydralazine		
	50 mg Tablets Antihypertensive		
	DIN 00005541	1 tablet orally at 8:00 with a full glass of water.	
	Expiry: 1.15.05		
	RX#: 31262	Dr. P. Sanders	
	Jones, Thomas	Room 37	Bed 2

Was the Hydroxyzine[®] label on the:

- ☐ *Left Side?* ☐ *Right Side ?*

Appendix 9

Test 4

1. In which of these pairs of labels is it easiest to see the difference between the drug names?
(Please circle the corresponding number) 1 2 3

2. Why do you think so?

1

Pleasantville Community Hospital
2219 -12 Street, Edmonton, AB, T2Z 1Y2
T: 780.453.9400 F: 780.453.9401

hydroOXYzine

50 mg Capsules
Anxiolytic

DIN: 00646016
Expiry: 1.15.05
RX#: 31263

Jones, Thomas

1 capsule orally at 8:00
with a full glass of water.
Dr. P. Sanders

Room 37, Bed 2

Pleasantville Community Hospital
2219 -12 Street, Edmonton, AB, T2Z 1Y2
T: 780.453.9400 F: 780.453.9401

hydrALazine

50 mg Tablets
Antihypertensive

DIN: 00005541
Expiry: 1.5.05
RX#: 31262

Jones, Thomas

1 tablet orally at 8:00
with a full glass of water.
Dr. P. Sanders

Room 37, Bed 2

2

Pleasantville Community Hospital
2219 -12 Street, Edmonton, AB, T2Z 1Y2
T: 780.453.9400 F: 780.453.9401

Hydrooxyzine

50 mg Capsules
Anxiolytic

DIN: 00646016
Expiry: 1.15.05
RX#: 31263

Jones, Thomas

1 capsule orally at 8:00
with a full glass of water.
Dr. P. Sanders

Room 37, Bed 2

Pleasantville Community Hospital
2219 -12 Street, Edmonton, AB, T2Z 1Y2
T: 780.453.9400 F: 780.453.9401

Hydralazine

50 mg Tablets
Antihypertensive

DIN: 00005541
Expiry: 1.5.05
RX#: 31262

Jones, Thomas

1 tablet orally at 8:00
with a full glass of water.
Dr. P. Sanders

Room 37, Bed 2

3

Pleasantville Community Hospital
2219 -12 Street, Edmonton, AB, T2Z 1Y2
T: 780.453.9400 F: 780.453.9401

Hydrooxyzine

50 mg Capsules
Anxiolytic

DIN: 00646016
Expiry: 1.15.05
RX#: 31263

Jones, Thomas

1 capsule orally at 8:00
with a full glass of water.
Dr. P. Sanders

Room 37, Bed 2

Pleasantville Community Hospital
2219 -12 Street, Edmonton, AB, T2Z 1Y2
T: 780.453.9400 F: 780.453.9401

Hydralazine

50 mg Tablets
Antihypertensive

DIN: 00005541
Expiry: 1.5.05
RX#: 31262

Jones, Thomas

1 tablet orally at 8:00
with a full glass of water.
Dr. P. Sanders

Room 37, Bed 2

Appendix 10

Test 5

1. In which of these pairs of labels is it easiest to find information?
(Please circle the corresponding number) 1 2 3

2. Why do you think so?

1

Pleasantville Community Hospital
2219 -12 Street, Edmonton, AB, T2Z 1Y2
T: 780.453.9400 F: 780.453.9401

Hydroxyzine
Novo-Hydroxyzin®

50 mg Capsules
Anxiolytic
DIN 00646016
Expiry: 1.15.05
RX#: 31263
1 capsule orally at 8:00 with a full glass of water.
Dr. P. Sanders
Jones, Thomas – Room 37, Bed 2

Pleasantville Community Hospital
2219 -12 Street, Edmonton, AB, T2Z 1Y2
T: 780.453.9400 F: 780.453.9401

Hydralazine
Apresoline®

50 mg Tablets
Antihypertensive
DIN: 00005541
Expiry: 1.5.05
RX#: 31262
1 tablet orally at 8:00 with a full glass of water.
Dr. P. Sanders
Jones, Thomas — Room 37, Bed 2

2

Pleasantville Community Hospital
2219 -12 Street, Edmonton, AB, T2Z 1Y2
T: 780.453.9400 F: 780.453.9401

Hydroxyzine
Novo-Hydroxyzin®

50 mg Capsules
Anxiolytic

DIN: 00646016
Expiry: 1.15.05
RX#: 31263
Jones, Thomas

1 capsule orally at 8:00
with a full glass of water.
Dr. P. Sanders
Room 37, Bed 2

Pleasantville Community Hospital
2219 -12 Street, Edmonton, AB, T2Z 1Y2
T: 780.453.9400 F: 780.453.9401

Hydralazine
Apresoline®

50 mg Tablets
Antihypertensive

DIN 00005541
Expiry: 1.5.05
RX#: 31262
Jones, Thomas

1 tablet orally at 8:00
with a full glass of water.
Dr. P. Sanders
Room 37, Bed 2

3

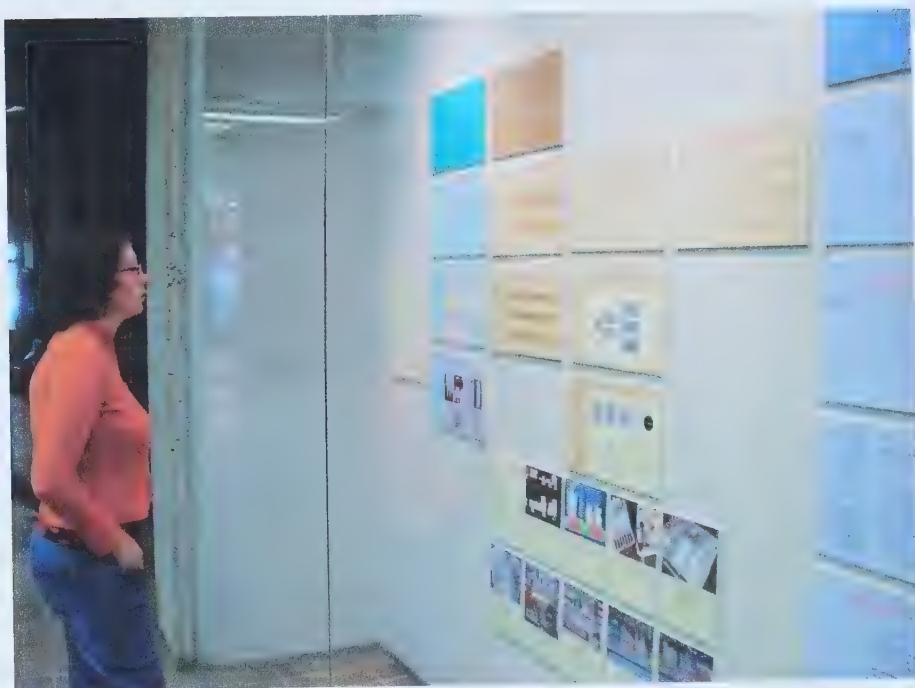
<div><div><div>Pleasantville Community Hospital 2219 -12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401</div><div><div>Hydroxyzine Novo-Hydroxyzin®</div><div>50 mg Capsules Anxiolytic</div></div></div></div>	DIN 00646016			1 capsule orally at 8:00 with a full glass of water.		
	Expiry: 1.15.05					
	RX#: 31263			Dr. P. Sanders		
	Jones, Thomas			Room 37	Bed 2	

<div><div><div>Pleasantville Community Hospital 2219 -12 Street, Edmonton, AB, T2Z 1Y2 T: 780.453.9400 F: 780.453.9401</div><div><div>Hydralazine Apresoline®</div><div>50 mg Tablets Antihypertensive</div></div></div></div>	DIN 00005541		1 tablet orally at 8:00 with a full glass of water.			
	Expiry: 1.15.05					
	RX#: 31262		Dr. P. Sanders			
	Jones, Thomas		Room 37	Bed 2		

Appendix 11

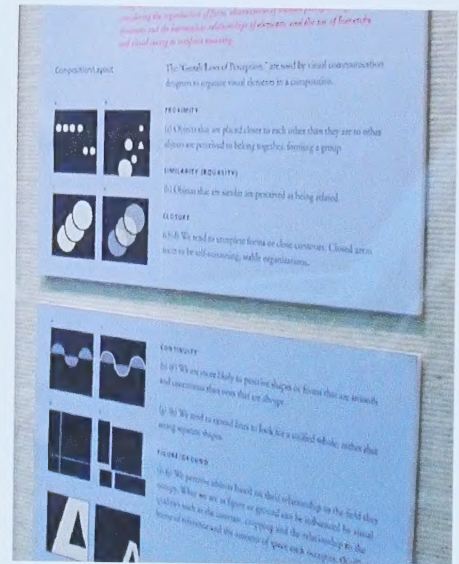
Thesis Exhibition

*Thesis Exhibition
Fine Arts Building
University of Alberta
Fall 2005*



Appendix 11

Thesis Exhibition



University of Alberta Library



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